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THE DISCOVERY OF TERTIARY MAN[1]

By Dr. HENRY FAIRFIELD OSBORN

RESEARCH PROFESSOR OF ZOOLOGY, COLUMBIA UNIVERSITY, HONORARY CURATOR OF VERTEBRATE PALEONTOLOGY, AMERICAN MUSEUM OF NATURAL HISTORY

THE discovery of Quaternary man was the central biological achievement of the nineteenth century. For twenty-four centuries the largely speculative idea of a natural rather than a supernatural origin of man had been slowly developing through the observations of zoologists and the dissections of comparative anatomists. From the time of Anaximander (547 B. C.), of Galen (131 A. D.), of Leibnitz (1700), of Buffon (1755), of Goethe (1790), of Erasmus Darwin (1794), of Lamarck (1809), of Chambers (1844), of Leidy (1847–1873) to that of Charles Darwin (1859–1871), one bit of evidence after another was added from comparative anatomy, until in the sixteenth century comparative zoology contributed the strong likeness to man of the anthropoid apes—the chimpanzee and gorilla of Africa, the gibbon and orang of eastern Asia. The most significant and prophetic observations in comparative anatomy were those of Goethe in the discovery of a separate intermaxillary bone in the upper jaw of man which both he and Leidy rightly interpreted as linking men with the apes and other primates in which the upper jaw is composed of two bones. Up to 1859 the relatively new science of paleontology had contributed nothing, because the female Neanderthal skull of Gibraltar in 1848 and the male Neanderthal calvarium of Germany in 1856 were misinterpreted by Virchow, Huxley and other anatomists.

I emphasize comparative anatomy and zoology, for as regards *direct* evidence our speculative position toward Tertiary man in 1929 is very much the same as Lamarck's and Darwin's speculative position toward Quaternary man between 1809 and 1871, because we are still largely dependent upon the facts afforded by comparative anatomy and comparative zoology, in the absence of direct paleontologic evidence in Middle and Lower Tertiary time. This statement is not true as regards *indirect* evidence, for human paleontology is now in a very strong position even to the very base of Quaternary time, a period estimated by geologists at 1,250,000 years. Fossil human remains of over 100 Quaternary individuals have been found including: *Palaeanthropus neanderthalensis* of Neanderthal, 48+; *Homo sapiens* of Cro-Magnon and Chancellade, 42; 2 of the Trinil race of Java, *Pithecanthropus erectus;* 2 of the Piltdown race, *Eoanthropus dawsoni;* 1 of the Heidelberg race, *Palaeanthropus heidelbergensis,* also 1 and possibly 2 more individuals recently reported by Freudenberg under the name *Hemianthropus;* 27 of the recently discovered Chinese *Sinanthropus pekinensis* (Schlosser, 1903; Zdansky, 1926; Black, 1927–1928). All these human fossils constitute a firm and broad human paleontology for Quaternary time and the close of Tertiary time. Each generic name, *e.g.*, *Palaeanthropus*, *Pithecanthropus*, *Eoanthropus*, *Sinanthropus* and *Homo*, demonstrates an entirely distinct branch of the fossil human families of Quaternary time; each branch is known to paleontologists as a *phylum,* and the special scientific analysis of these several branches is termed *phylogeny.* Phylogeny is a relatively new and very important branch of biology, the principles of which were entirely unknown to Darwin (1859–1871) and only in part known to Huxley, as they are now revealed by the brilliant and world-wide discoveries by invertebrate and vertebrate paleontologists. My forecast of the Tertiary anatomy and habits of the "dawn-man" is greatly influenced by our direct knowledge of the phylogeny of other mammals.

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[1] Address of the retiring president of the American Association for the Advancement of Science, Des Moines, December 27, 1929.

As Quaternary fossil man was the central biological contribution of the nineteenth century, so Tertiary man constitutes the goal and peak of biological discovery in the twentieth century. Thus far I have been dealing with well-known facts because these Quaternary fossil men have become household words all over the world. On the other hand, the discussion of Tertiary man carries us into the unknown, into one of the most interesting fields of human speculation and anatomical controversy, into several divergent camps of human opinion and interpretation, along several great lines of comparative anatomy of the principal organs concerned, namely, the brain, the skull and jaws, the limbs, the hands and feet. Both with Lamarck and Darwin the "ape-man" descent was never more than a working hypothesis based upon the closer approach of the anthropoid apes to man than that observed in any other group, for want of any positive data. Both Lamarck and Darwin postulated a *reversible* evolution in function and structure whereby an animal with all the psychical and anatomical adaptations of arboreal apes could secondarily take on a gradual change of habit and function and gradually enter a new erect career with radical changes in habit and in mind as well as in the anatomy of limbs, hands and feet. Darwin's starting-point (1871), after picturing as our ancestor a hypothetical ape not far from a primitive Miocene chimpanzee, concluded with the following all-important sentence both as to habit and habitat:

> *The foot was then prehensile, judging from the condition of the great toe in the foetus; and our progenitors, no doubt, were arboreal in their habits, and frequented some warm, forest-clad land.*

Quite recently (August, 1927), before the British Association, President Keith summed up this hypothesis as follows:

> DATE OF MAN'S EMERGENCE. It is useless to go to strata still older than the Miocene in search of man's emergence; in such strata we have found only fossil traces of emerging anthropoids. All the evidence now at our disposal supports the conclusion that man has arisen, as Lamarck and Darwin suspected, from an anthropoid ape not higher in the zoological scale than a chimpanzee, and that the date at which human and anthropoid lines of descent began to diverge lies near the beginning of the Miocene period. On our modest scale of reckoning, that gives man the respectable antiquity of about one million years.

This Lamarck-Darwin working hypothesis has been greatly strengthened and in large measure adopted by an army of human and comparative anatomists including all the leading and most brilliant men of our time such as Sir Arthur Keith (1927), Dr. G. Elliot Smith (1926–1928), Professors William King Gregory, Dudley J. Morton and Robert M. Yerkes, as well as by a host of other able but less widely known anatomists. So great has been the force of nearly unanimous adherence to the Lamarck-Darwin hypothesis that it has gained world-wide acceptance even among the most intelligent scientists, as may be seen in passages in two outstanding works of the present decade, Eddington's "The Nature of the Physical World" (1928) and Jeans's "The Universe Around Us" (1929). A parallel instance of the world-wide assumption of a working hypothesis is that of Lamarck's hypothesis of the inheritance of acquired characters as the prime cause of evolution. Although never demonstrated, the Lamarckian hypothesis was universally accepted until Weismann gave it a death blow in 1880. Such may be the fate of the "ape-man" hypothesis.

I was myself rather suddenly converted to the opposite "dawn-man" hypothesis in a roundabout manner. When in 1919 after years of search the American Mu-

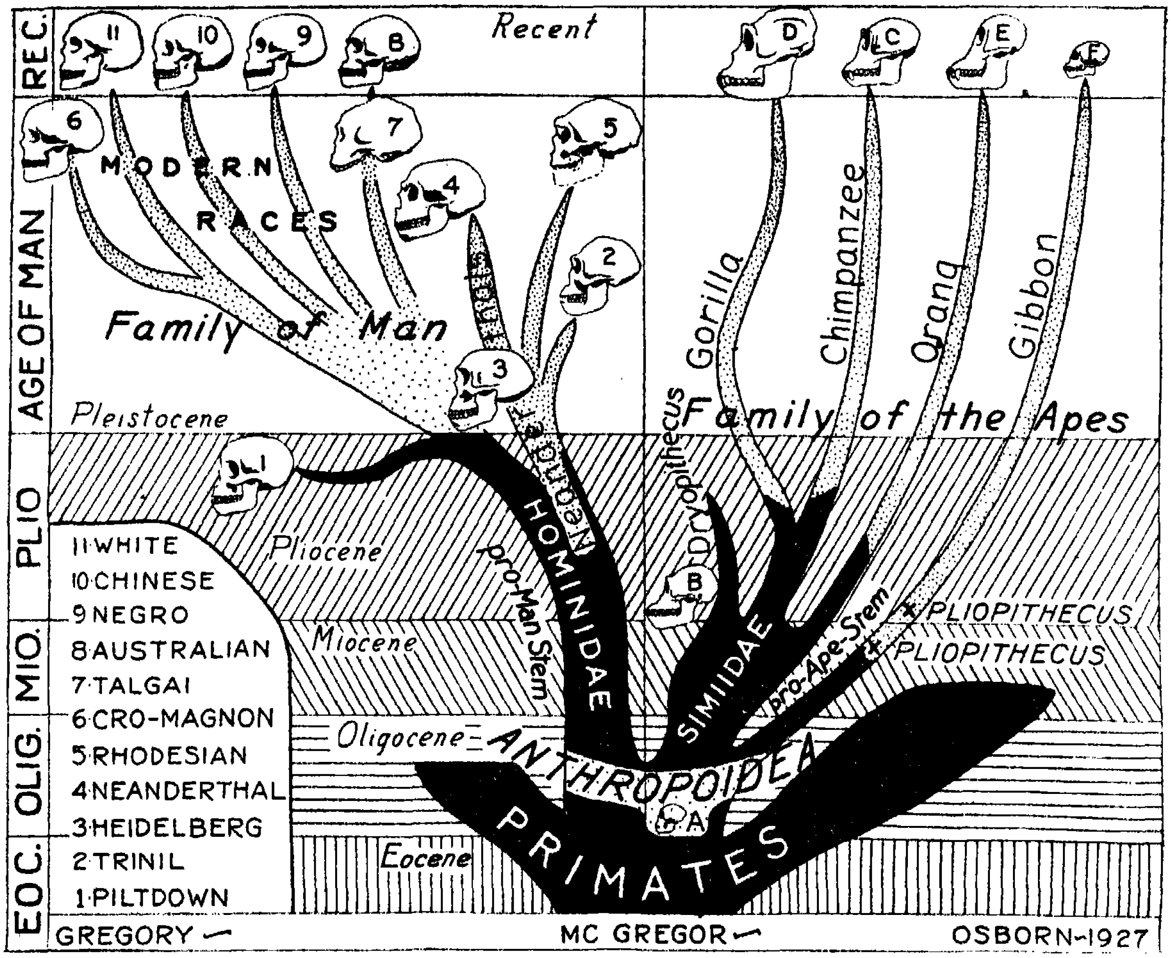

FIG. 1. OSBORN'S PRESENT THEORY OF THE ASCENT AND PHYLOGENY OF MAN.

Left: Family of Man (*Hominidae*), dividing into the Neanderthaloid and modern racial stocks; present geologic location of the Piltdown, Heidelberg, Trinil, Neanderthal and Rhodesian fossil races. Right: Family of the Apes (*Simiidae*), including the Pliocene and Miocene dryopithecoids nearest the ancestral stock of the Anthropoids, also the lines leading to the gorilla, orang, chimpanzee and gibbon. Below: Anthropoidea, the common Oligocene ancestors of the *Hominidae* and of the *Simiidae*.

seum discovered in Middle Pliocene time the complete skeleton of a horse, named *Pliohippus leidyanus*, a perfect horse in all except name and perhaps color, the bearing of this case of precocious adaptation on human descent flashed across my mind, and before a meeting of the National Academy of Sciences I predicted that the greatest surprise in store for twentieth-century science would be in the discovery of a large-brained Tertiary man! This anatomical prophecy has unexpectedly been confirmed by recent paleontologic evidence that *Eoanthropus*, the "dawn-man" of Sussex, is of Upper Pliocene or Tertiary age.

The large brain of *Eoanthropus* suggests as our first quota of counter-evidence a review of our greatly enriched knowledge of the Quaternary fossil brain.

BRAIN SURPRISES OF QUATERNARY DISCOVERY

These surprises arise from the profound researches and independent discoveries of Dubois, Smith Woodward, Boule, Keith, McGregor, Black, Economo and Leboucq, to which honor roll we should add Frederick Tilney's "The Brain from Ape to Man" (1928). The six outstanding points as to the brain are as follows: (1) that certain races of fossil man of the last 1,250,000 years had a brain cube equal to or greater than that of modern man; (2) that the much-despised cave man (*Palaeanthropus*) was inferior to ourselves neither in brain cube nor in hand ability, although far inferior to ourselves in civilization; (3) that certain of the cave men (*Homo sapiens*, Cro-Magnon) were our superiors both in average brain capacity and in average artistic ability; (4) that at the close of Tertiary time there lived a race (*Eoanthropus dawsoni*) with a brain cube equal to the minimum of that of the living Veddahs, Papuans and native Australians; (5) that the ratio of human brain weight to body weight in Quaternary time was apparently the same as it is to-day, namely, 1:50

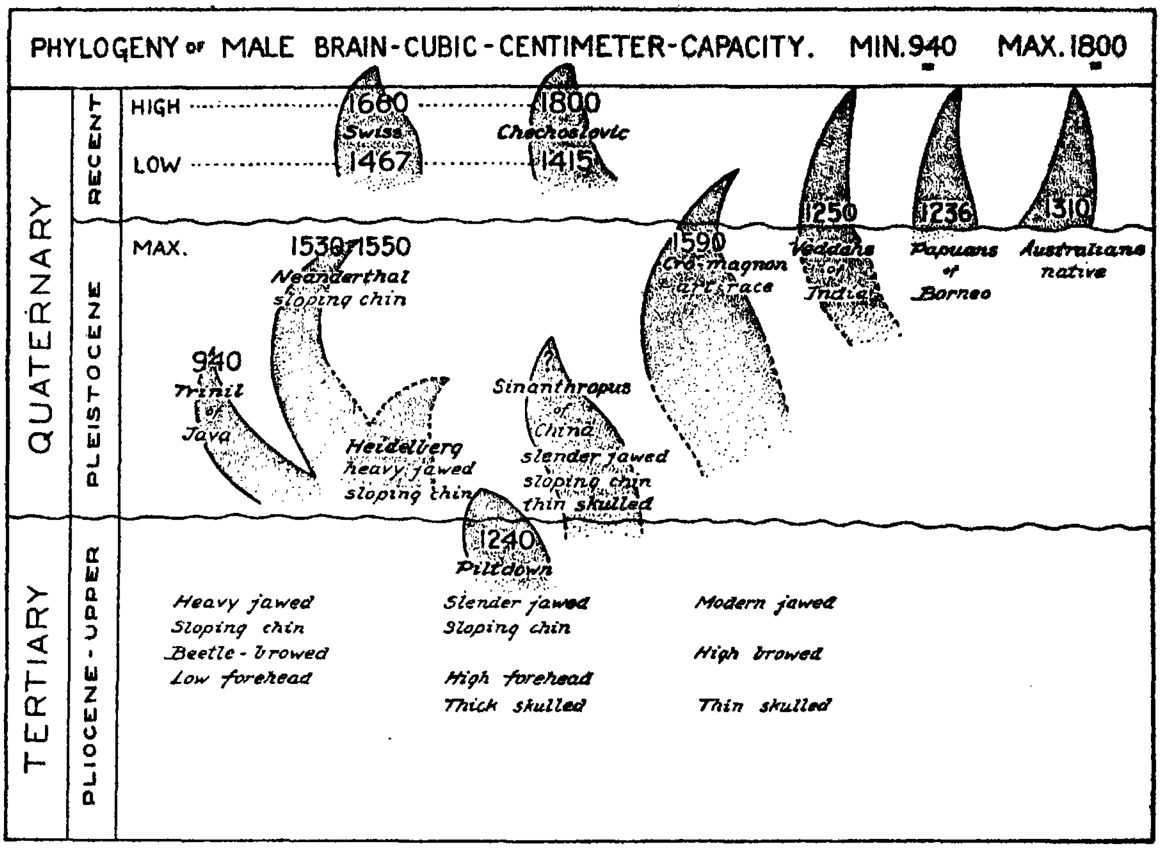

Fig. 2

(Weber, 1896), in contrast to the anthropoid apes, in which it is as follows:

	Brain to body weight ratio
Super-arboreal Gibbon of southeast Asia (130 gr.)	1: 66 or 1: 73
Arboreal Chimpanzee of west Africa (412 gr.)	1: 51 or 1: 61
Super-arboreal Orang of Borneo (400 gr.)	1: 183 or 1: 194
Terrestrial-arboreal Gorilla of central and west Africa (565 gr.)	1: 150 or 1: 200

(6) as Dietrich has shown, *Pithecanthropus*, the Trinil race of Java, is not an ancestral Pliocene type, as was formerly supposed, but a surviving mid-Pleistocene branch, the companion of a stegodont elephant; the Trinil brain is a case of arrested development.

The conclusion is inevitable that *the main cubic evolution of the human brain took place during antecedent Tertiary time and not, as we formerly thought, during the Quaternary Age of Man or Glacial period.*

These six points are supported by the following comparison:

	Brain cube in cc
Summit of Quaternary and *Modern* time:	
Homo sapiens, Cro-Magnon of Mentone	1550
Palaeanthropus, Neanderthal Caveman, La Chapelle-aux-Saints	1530
Homo sapiens, average modern Swiss	1467
" " average modern European	1450
" " Alpine race of Czechoslovakia	1415
Homo sapiens, fossil Alpine race of Ofnet	1400
Homo sapiens, native Australian race	1310
" " native Indian Veddahs	1250
Mid-Quaternary:	
Pithecanthropus erectus (Trinil man of Java)	940
Summit of Tertiary:	
Eoanthropus dawsoni (Piltdown Dawn Man)	1240
Living Papuans of New Guinea	1236

It is well known that the *brain cube* is not a reliable test of brain power or capacity, as Leboucq has recently pointed out in striking examples from recent times:

	Brain weight in grams
Tourgenieff, Russian novelist	2,012
Cuvier, founder of paleontology	1,829
Byron, poet	1,807
Gambetta, statesman	1,246
Anatole France, littérateur	1,017 (to 1,317)

Doubtless this *cube-versus-intelligence* disparity in brain function also prevailed during the Quaternary Age of Man, although in the few fossil cases where comparison is possible we note a similar disparity between male and female brain weight.

We must therefore adduce collateral and very substantial proof that Upper Tertiary man, whom we may provisionally designate "the dawn man" after Smith Woodward's well-chosen term *Eoanthropus*, made highly intelligent use of his 1,240–1,300 cubic brain measurement.

This brings us to the most startling discovery of the twentieth century, the full significance of which we have only recently learned to estimate.

THE FIRST POSITIVE DISCOVERIES OF TERTIARY MAN

Archeologists are still divided as to the human origin of *eoliths*, so that we can not class these rude flints as positive evidence.

One of the most striking coincidences in the history of human paleontology is that indubitable flint implements of Tertiary men were discovered by J. Reid Moir on the east coast of Anglia in the year 1909 and that in 1911, only two years later, an indubitable human skull and jaw of what proves to be Tertiary man were found in Piltdown, Sussex, by Charles Dawson. It has required eighteen years of research by Moir and Smith Woodward, aided by the most able archeologists and anatomists of the world, to establish the full significance of these epoch-making discoveries of 1909–11. By adding year by year implement after implement from two strata of Upper Pliocene time, J. Reid Moir, originally an amateur collector of Ipswich, has finally overcome all incredulity and even hostility and has thoroughly established the Red Crag and sub-Red Crag strata of the Upper Pliocene coast of Anglia as the site of a widespread and highly varied flint and bone industry, including the "eagle's beak" (rostro-carinate), "skin cutter," "side scrapper," "push plane," "borer" and "chopper" and "piercing tool," all indicating a race of hunters highly adept at flint flaking; finally, for killing purposes, a perfected "sling-stone," ranking as a work of Paleolithic art. All these artifacts have been confirmed and recently embodied in the Stone Age chronology of Abbé Henri Breuil (December, 1929). Breuil not only accepts the Tertiary age, but in his latest paper (December, 1929) shifts the entire pre-Chellean and Chellean flint industries from mid-Quaternary down into the base of Quaternary time, namely, into the first Interglacial or Mindel-Riss stage; this obviously shifts the pre-Chellean and Chellean flint-making design and intelligence down close to Tertiary time—in fact, some of Reid Moir's flints are identical with the Chellean artifacts.

Meanwhile Osborn, by world-wide study of fossil elephants and mastodonts, has firmly established these Reid Moir flint beds as of Upper Pliocene or close of Tertiary time, against the contention of the late Ray Lankester that these flints were early Pleistocene. Hardly less positive is Osborn's determination, with the aid of Reid Moir, Freudenberg, of Heidelberg, Matsumoto, and Bather and Hopwood, of the British Museum, that the Piltdown race—*Eoanthropus dawsoni* of Smith Woodward—is of Upper Pliocene Tertiary age rather than of Quaternary age as formerly supposed.

Both the Red Crag of Suffolk and the Piltdown beds of Sussex yield a very primitive species of elephant generally known as *Elephas planifrons* (first discovered, 1858, by Falconer in the upper Siwaliks of India), whose migrations are now traced from the Vaal River of South Africa (Broom) northward into Italy and England, far eastward into India, with absolutely definite measurement and form of the enameled ridge-plates of the grinding teeth which in the elephants and mammoths give us *a new and quite dependable means of dating all the fossil man discoveries of Upper Tertiary to Recent time.* Upper Tertiary man is thereby shown to have been an elephant hunter, probably for bone and ivory as well as for flesh, over a million years ago. This discovery also paves the way for the great intercontinental migration routes and the African-Eurasian dispersal of man even in as remote a period as the Upper Pliocene.

In view of the fact now established that even in the Upper Pliocene man was an extremely adept flint worker, with deft hands and fingers guided by an imaginative and intelligent forebrain, it seems probable that Upper Pliocene man, like his companion the Upper Pliocene elephant, was already a nomad and needed long and agile lower limbs as his only means of distant transportation. We are thereby forced to reconsider Darwin's concept of the primitive ape-man as inhabiting a "warm, forest-clad land."

TRAVELING LIMBS AND TOOL-MAKING HANDS OF TERTIARY MAN

Fifty-eight years of incessant zoological and comparative anatomical research have been focused upon the anatomy and embryology of the apes and man to find out the bearing of the recapitulation or biogenetic principle of Haeckel on the ancestral Tertiary hands and feet of man. Recently Morton (1927), Schultze (1925–29), Straus (1927), Gregory (1925–29), Hrdlička (1928), have devoted special memoirs to this problem, Straus summing up in the paraphrased words: The foot of embryonic man is of a structure unfitted for an upright terrestrial existence. It is in most characters not unlike that of an adult gorilla, although in some respects even more primitive than that of the largest anthropoid apes. The chief point of embryonic resemblance is in what Darwin termed "the prehensile big toe," but the paleontologist Matthew (1928) has pointed out that all primitive Eocene mammals, both arboreal and terrestrial, had the big toe well set apart from the others. This stronghold of "prehensile big toe" evidence, therefore, carries man far back of the highly specialized anthropoid ape big-toe stage and tends to sustain the "dawn man" contention that even the embryonic foot of man may date back to the more remote Upper Eocene time.

This contention is even more strongly borne out by the embryonic human hand, in which there is no evidence whatever of having passed through an anthropoid ape limb-grasping stage. While the newest analysis of the embryonic hind limbs may leave us in doubt as to a possible case of reversed evolution from the Miocene ape leg to the human stage, the human hand and the human brain, especially in the light of *Eoanthropus* discoveries, seem to dissipate some of the doubts raised by the feet and strengthen the new "dawn man" hypothesis of a very remote separation of our running and tool-making ancestors of the plateaus and savannas from the same great stock (Anthropoidea) which independently gave rise to the tree-loving anthropoids of the tropics.

No one should misunderstand the "dawn man" hypothesis I have been advocating in a series of papers and addresses since April 7, 1927. I am not ignoring the strong evidence for an Eocene arboreal stage in our ancestry; I am not ignoring the overwhelming evidence of a remote community origin between man and the anthropoid apes; I am combating the special feature of the Lamarck-Darwin hypothesis that man once passed into highly specialized arboreal adaptations attained by the Miocene apes; finally, I am inclined to separate the human stock at a geologically earlier pre-Miocene period of anthropoid evolution. In the geologic remoteness of this momentous separation of the "dawn man" stock we are aided by a mass of collateral evidence utterly unknown in the time of Darwin.

This brings us back to the sub-science of phylogeny spoken of above, which, in popular terms, aims at the reconstruction of the family tree of man by principles recently discovered in the family trees of other mammals.

NEW PRINCIPLES OF PHYLOGENY APPLIED TO MAN

First, we have discovered that the geologic period of separation of the adaptively radiating branches in many families of mammals is of an antiquity undreamt of even a few decades ago. Even in Lower Eocene time all the existing families of hoofed mammals, such as the horses, tapirs, rhinoceroses and titanotheres, had widely separated from each other in tooth, limb, hand and foot structure. Before the close of Eocene time these branches were further subdivided into forest-loving and plateau-loving types; in every branch the forest-loving types were stationary or regressive. Similarly, by the close of Eocene time the mastodont and elephant families are found widely separated into five greater branches (in Oligocene time there were numerous sub-branches and in Miocene time eighteen distinct branches). In the succeeding Oligocene time we discover a sharp and world-wide division between plateau-loving and forest-loving types: in the forests remain all the backward conservative types; on the plateaus and uplands are found the alert, progressive, forward-looking types, including all the long-hind-limbed bipedal animals adapted to rapid progression in an open or partly forested country. It is no exaggeration to say that at the dawn of Oligocene time all the plateau-loving animals are distinctly modernized both in habits and in bodily proportions.

Is it likely that the primates alone escaped this divorce between backward, forest-loving life and forward, plateau, savanna and upland life, especially as Eocene forest areas in every continent began to contract and upland open plains and plateaus began to expand?

A second principle of modern phylogeny is that every ancestral stage, whether of horse, rhinoceros or elephant (the three kinds of animals I have most intensively studied for the past thirty years), preserves the hundred per cent. *structural equipment* for giving rise to its more recent or modernized descendants; each branch has the potentiality of the remotest twigs of descent. Through change of function nature may transform an organ but it can never restore a single lost part, whether it be a lost tooth, a lost digit, a lost ankle bone or rib, a lost tendon or nerve. This is Dollo's principle that *the evolution of anatomical organs is never reversible even though the evolution of functions and habits is frequently reversible.* On this principle the human hand could never reacquire the nerves, muscles, functions, freedom, flexibility and separate innervation lost in the highly specialized arboreal ape hand; the opposable human thumb could not spring back from the partly atrophied anthropoid ape thumb. Our quadrupedal ancestors certainly had a forefoot capable of developing into the human hand with its long flexible fingers separately innervated and its thumb which, as Erasmus Darwin postulated, could reach the tip of each finger in turn, all depending upon separate innervation from special cell centers in the spinal cord and brain. Primitive man is not only a tool-making animal, he is a music-making animal; consider "Blind Tom," the negro musical genius of his day, who not only possessed an excellent finger technique but a marvelous musical memory that enabled him after a single hearing to repeat elaborate piano compositions. In this human hand connection let us recall also the researches of Sir Richard Paget in advocating the gesture origin of human speech, as gesture demands flexible fingers.

Third, to this hundred per cent. structural equipment of our remote ancestors phylogeny adds a hitherto unperceived germinal potentiality of specialization along certain pre-determined directions rather than others in adaptive reactions to changes of environment; this *teleogenesis* rests upon thousands of observations among primates, horses, titanotheres and elephants which prove that parallel anatomical and psychical progress is traceable to germinal community of origin. The psychic resemblances of the apes to man are partly parallelisms, partly common inheritance (Yerkes). Teleogenesis is not to be confused with the old "teleology," nor is it a revival of a hypothetical vitalism or internal perfecting tendency.

Finally, and perhaps from glandular impulses (Keith), phylogeny proves that independent of selection, of environment, of habit, certain phyla exhibit rapid or accelerated physical and mental adaptation, while others are held back. The creative brain, the tool-making hand, the fleet hind limb of man apparently combine in accelerated adaptation, while forest-loving primates advance much more slowly.

Does not this unbiased survey of recent discoveries in archeology, human and comparative paleontology and human and comparative anatomy, compel us to reconsider the classic Darwin-Lamarck hypothesis and to substitute a new hypothesis? The new hypothesis carries us into a geologic antiquity hitherto undreamt of. Anthropology is forced to share with chemistry and physics entirely new notions of space and time. To my mind the human brain is the most marvelous and mysterious object in the whole universe and no geologic period seems too long to allow for its natural evolution.

OBITUARY

KARL VON DEN STEINEN

THROUGH the sudden death of Karl von den Steinen, which occurred on the fourth of November, 1929, anthropology has lost one of its most eminent representatives.

Born in 1855 at Mühlheim a./d. Ruhr, he attended the Gymnasium of Düsseldorf, from which he graduated in 1871. He studied medicine at the Universities of Zurich, Bonn and Strassburg, devoting himself particularly to psychiatry. He was assistant at the Charité in Berlin, but soon he gave up this position and took a journey around the world which lasted from 1879 to 1881. On this journey he met Adolf Bastian in Hawaii and accompanied him on his visits to the natives. Bastian's enthusiasm for ethnological problems, the varied experiences of the long journey and contact with many foreign cultures were probably the causes that determined von den Steinen's ever-increasing devotion to the problems of anthropology.

At that time, however, geographical problems were nearer to his mind. In 1882 he was a member of the German party in charge of the meteorological station in South Georgia—one of the series of stations that were to observe for a year the meteorological and magnetic conditions in both circumpolar regions. Later on he published his observations, made during this year, on the life of the seals and birds of South Georgia. Immediately upon his return in 1884 he organized an expedition through Central Brazil and explored the Xingú, one of the southern tributaries of the Amazon, which up to that time was entirely unknown. This journey yielded important geographical results and at the same time brought him into close contact with the primitive natives of this area who were at that time still almost entirely untouched by European civilization. His account "Durch Zentral Brasilien" gave the results of his observations. Not satisfied with the completeness of his studies, he returned to Brazil in 1887 and devoted himself entirely to the study of the natives of the Xingú region. For several years after his return he was occupied with work on the results of this expedition which was finally published in 1894 under the title, "Unter den Naturvölkern Zentral Brasiliens," a book which has become one of the classics of ethnological literature. He published his linguistic observations in 1892 as a grammar of the Bakairí language.

Meanwhile he had accepted a chair at the University of Marburg where he taught for two years, 1891 and 1892. At the same time he was editor of the *Ausland*, an old, well-established journal that contained particularly ethnological and geographical information. The duties of these positions were not congenial to him because they absorbed too much of the time that he wished to devote to research, and soon he returned to Berlin where, in 1896, he was elected president of the Berlin Geographical Society.

His interest in the problems of the Pacific Ocean never flagged. In 1897 he went to the Marquesas Islands. He visited every island and every village and amassed most valuable ethnological material. On his return journey in 1898 he visited some of the northwestern tribes of Canada. Then followed years of unremitting study. He was never satisfied with the mere collection of material but saw in it a means of solving problems. Ever since his Brazilian journey the question of primitive art was uppermost in his mind, and the interpretation of the curious and intricate forms of Marquesan art was one of the attractions that this remote group of islands held out to him. With indefatigable persistence he visited all the museums of Europe and America and accumulated material for the study of the historic development of Marquesan art during the period of our knowledge of the islands. His purpose was the attempt to reconstruct the earlier history of this art. Work on this particular problem was interrupted by the duties which he undertook as director of the South American department of the Ethnological Museum of Berlin, a position which he occupied from 1902 to 1906. Again he found that administrative duties made too heavy demands on his time and he returned to the problems that interested him most profoundly.

During this period he took a most active part in the scientific life of Berlin. From 1908 to 1910 he was president of the Berlin Anthropological Society, and his house was the center to which all interested in ethnological studies resorted. It is largely due to his influence that Germany has taken a prominent part in anthropological work in South America. Paul Ehrenreich, Max Schmidt and Theodor Koch-Grünberg were all stimulated by his enthusiasm.

It is fortunate that it was given to him to see published his great work on the art of the Marquesans. The first volume appeared in 1925, the second and third volumes in 1928. In his book on Brazil he had taken the view that all geometrical art developed through conventionalization of realistic forms. In later years he abandoned this view, and the value of his great Marquesan work lies in the attempt to interpret on the basis of painstaking formal analysis the many directions art forms take under the conditions of technique and of constant reinterpretation. The wealth of material and the penetrating analysis of forms are such that now, since the book has been in our hands only a short time, it is quite impossible to assess fully its value, but there can be no doubt that his method of examination sets a new standard for all studies of similar subjects, not only in art but equally in religion, ceremonial life, social structure and invention. We deeply regret that it was not given to him to work out by similar methods the large mass of traditional literature that he collected. His Marquesan work stands out as an example of thoroughness and of critical acumen.

In his younger years von den Steinen, because of his wide knowledge and his rare social gifts, exerted a wide influence, but as he grew older he retired more and more to his study. His counsel was sought but he did not take an active part in scientific affairs. His personal charm and his loyalty endeared him to all who had the privilege of knowing him intimately, and his friends mourn his death no less as a personal loss than as a loss to science.

FRANZ BOAS

COLUMBIA UNIVERSITY

RECENT DEATHS

PROFESSOR RALPH H. CURTISS, professor of astronomy and director of observatories at the University of Michigan since 1927, died on December 25 in his fiftieth year.

A CORRESPONDENT writes that Emile Francis Williams, a charter member of the New England Botanical Club and from 1896 to 1917 its recording secretary and treasurer, died at his home in Cambridge, Massachusetts, on December 19, in his seventy-second year. He was born in Boston on January 11, 1859, and spent his early youth in France, where he received his early education in Paris. Returning to America he continued his studies at the Massachusetts Institute of Technology, from which he was graduated from the civil engineering course in 1878. For many years he engaged in business as an importer of rugs and other oriental goods of rarity, devoting, however, much of his time to the pursuit of botany. He made frequent visits to the less explored portions of New England and the adjacent parts of the Maritime Provinces. He had exceptional skill in the selection and preparation of plant-specimens and built up a personal herbarium of unusual excellence. This, including about 14,000 sheets of mounted specimens, he gave to the Gray Herbarium of Harvard University, of which he had, for many years, been a highly valued member of the visiting committee. He was one of the founders of the New England Botanical Club and during more than twenty years devoted much care to its exploring activities, the upbuilding of its collections, a very methodical record of its meetings and an effective oversight of its finances. After his retirement from business he traveled much in southern central France and brought out his experiences in a work called "Undiscovered France," a beautifully illustrated volume of unusual insight and charm.

SCIENTIFIC EVENTS

SITE FOR A NEW OBSERVATORY AT THE UNIVERSITY OF MICHIGAN

THE University of Michigan has acquired by purchase two hundred acres of land lying along the left bank of the Huron River, which will be used as a site for a new astronomical observatory. The site had the approval of the late Professor Ralph H. Curtiss, director of astronomical observatories, and was also approved by the late Professor William J. Hussey. It includes, according to an account in *The Michigan Alumni*, a commanding elevation close to but not on a main highway, and is entirely removed from the smoke, vibration, city lights and other conditions which have in recent years continued in increasing degree to make modern astronomical study impossible in the present observatory.

Architects' plans have already been drawn for an observatory designed to accommodate a 75-inch telescope and all the other apparatus required in modern astronomical investigations. The building, according to the plans, will be unpretentious but substantial and fireproof. Aside from the telescope building, the university plans to build a residence for the keeper and the observing staff, and estimates that the cost of the entire undertaking will be $260,000.

Seventy-five years ago the present observatory was built and equipped with what was then one of the best obtainable telescopes. At that time it was located on the edge of town, where the air was clear, and there were no buildings near by. Since that time it has been hemmed in upon all sides, the view of the skies is obscured by smoke from the university powerhouse, and the operation of the delicate instruments is made nearly impossible by the continual jars caused by the heavy traffic on Ann and Observatory Streets. It is impossible to carry on research work under these conditions. The telescope, which was one of the finest in the country at the time of its purchase many years ago, is now outdistanced by the modern instruments at Harvard, Mt. Wilson, Ohio Wesleyan and Victoria, B. C., and its field is said to be practically worked out.

If the observatory is moved, the university will come into possession of thirty-two acres of land inside the limits of Ann Arbor, which will be free from all restrictions. Four of these acres are used as the site of the present observatory. This property was purchased in 1854 by a fund to which the Honorable Henry N. Walker, Senator Zachariah Chandler, General Lewis Cass and Governor Henry P. Baldwin contributed. There are twenty-six acres of ground east of Observatory Avenue, adjoining the Hospital grounds, which Robert P. Lamont has held for some time for the use of the observatory, as well as two additional acres on which the university has been allowed to erect buildings, with the understanding that other provisions would be made to meet the needs of the observatory. If the observatory is moved, this land will be deeded to the university.

THE INTERNATIONAL CONGRESS OF SOIL SCIENCE

IN accordance with the decision of the general committee of the International Congress of Soil Science meeting on July 6 in Budapest, the sessions of the second congress will be held in Leningrad from July 20 to 31, 1930, under the presidency of C. C. Gedroiz. The first six days the meetings will be in Leningrad and the remaining time will be spent in Moscow. In both cities a series of excursions will be arranged and exhibits of general soil science including special displays devoted to agronomical and forest soil science, utilization of marshes, technical processes of cultivation, land taxation, etc.

After the congress an excursion of twenty-nine days will be made across the soil zones of the European part of Soviet Russia, during which the members will have the opportunity of visiting higher schools, agricultural experiment stations, agricultural and industrial enterprises, etc.

The excursion will be made by special railway trains supplied with sleeping-cars and dining cars, and by steamer on the Volga and the Black Sea. Out of the twenty-nine excursion days three days will be given for rest, two in the Caucasus and one in the Ukraine. In addition to this excursion, special excursions may, if desired, be arranged: (1) to the Mourman peninsula for visiting peat-soils, forest swamps, the biological station, the railroad colonization, etc.; (2) to central Asia, and (3) to the agricultural exhibit of Minsk (White Russia) and other places. A discount of 50 per cent. is given on the railway fares. Members desiring to attend both congress and excursions are requested to communicate with Professor Dr. A. Yarilov, president of the Organizing Committee, Moscow, Karuninskaja, Gosplan, not later than February 1, stating at the same time the town in which they would like to receive the visa to enter Russia.

The organizing committee undertakes to secure the visas required for entering and leaving Russia and to provide on request, rooms, food and vehicles for the entire period of the congress and excursions. Towards these expenses the members of the general committee of the International Society of Soil Science and members who have some special share in the work of the society will pay on their arrival at Leningrad $300 to the organizing committee. *All* other members who have paid their yearly subscriptions up to January 1 will pay $350, while those who have joined after January 1 will pay $450. The expenses of those who do not participate in the excursions will be $110. Those wishing to accompany the excursion only as far as Stalingrad on the Volga can leave the party conveniently at the point. The prices of railway tickets are quoted to Leningrad as follows: From Berlin via Warsaw-Negoreloie: 2nd class $32; 3rd class $22; from Warsaw: 2nd class $22; 3rd class $13; from Riga: 2nd class $12; 3rd class $8; from Stockholm via Abo: 2nd class $16; 3rd class $9; entrance and departure visas (both) $5.50.

THE AUSTRALASIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE Australasian Association for the Advancement of Science will hold its twentieth meeting at Brisbane during the week beginning on May 28, 1930. The president-elect of the association is E. C. Andrews, government geologist, Sydney, and the vice-presidents are Professor Sir T. W. Edgeworth David, emeritus professor of geology in the University of Sydney (president, Dunedin meeting, 1904, and Melbourne meeting, 1913); Professor Sir David Orme Masson, emeritus professor of chemistry in the University of Melbourne (president, Sydney meeting, 1911); Professor Sir W. Baldwin Spencer, emeritus professor of biology in the University of Melbourne, director of the National Museum, Melbourne (president, Hobart-Melbourne meeting, 1921), and Lieutenant-General Sir John Monash, chairman, State Electricity Commission of Victoria (president of the Adelaide meeting, 1924).

The association meets in sixteen sections, each presided over by a president and several vice-presidents. The sections and their presidents are as follows:

Section A—Astronomy, Mathematics and Physics. President, J. M. Baldwin, Observatory, Melbourne.

Section B—Chemistry. President, Professor E. J. Hartung, The University, Melbourne.

Section C—Geology. President, E. de Courcy Clarke, The University, Perth.

Section D—Zoology. President, R. J. Tillyard, Commonwealth Entomologist, Canberra.

Section E—History. President, Professor J. R. Elder, University of Otago, New Zealand.

Section F—Anthropology. President, Professor A. R. Radcliffe-Brown, The University, Sydney.

Section G—Social and Economic Science and Statistics. President, D. T. Sawkins, Bureau of Statistics, Young Street, Sydney.

Section H—Engineering and Architecture. President, Professor Leslie Wilkinson, The University, Sydney.

Section I—Medical Science and National Health. President (to be announced).

Section J—Education, Psychology and Philosophy. President (to be announced).

Section K—Agriculture and Forestry. President, W. N. Jolly, Forestry Commission, Sydney.

Section L—Veterinary Science. President (to be announced).

Section M—Botany. President, H. H. Allan, Plant Research Station, Palmerston North, New Zealand.

Section N—Physiology and Experimental Biology. President, Professor T. Brailsford Robertson, The University, Adelaide.

Section O—Pharmaceutical Science. President, A. B. Chater, Care of Taylors and Elliotts, Valley, Brisbane.

Section P—Geography. President, Dr. C. Fenner, Adelaide.

POPULAR SCIENCE MONTHLY PRIZE AWARD

Popular Science Monthly announces that, beginning this autumn, it will confer an annual prize of $10,000, accompanied by a gold medal, upon the American citizen who has been responsible, during the *preceding year, for the achievement in science of* greatest potential value to the world.

In making this announcement, O. B. Capen, president of the Popular Science Publishing Company, explained that the award was instituted with a dual purpose—to heighten the interest of the American people in those conquests of the laboratory and the workshop which benefit the entire community, and to focus attention upon the many scientific workers who, without thought of personal profit, toil to better man's control over his physical surroundings.

The award will be bestowed under the auspices of the Popular Science Institute, a research organization maintained by the magazine, of which Professor Collins P. Bliss, associate dean, New York University, is director. The institute has enlisted the services of twenty-four leaders in American science to serve as a committee of award, whose task it will be to select the prize-winning effort.

The prize will be conferred for the first time in September, 1930, and the initial period of scientific accomplishment to be considered by the Committee of

Award will be the twelve months ending June 30, 1930. All scientific workers, professional and amateur, academic and commercial, are eligible.

The members of the Committee of Award are:

Dr. Charles G. Abbot, secretary, Smithsonian Institution; Professor Collins P. Bliss, director, Popular Science Institute; Dr. Samuel A. Brown, dean, New York University and Bellevue Hospital Medical College; Dr. George K. Burgess, director, United States Bureau of Standards; Dr. William W. Campbell, president, University of California; Dr. Harvey N. Davis, president, Stevens Institute of Technology; Dr. Arthur L. Day, director, Geophysical Laboratory, Carnegie Institution; Dr. E. E. Free, consulting engineer; Travis Hoke, editor, *Popular Science Monthly;* Dr. Frank B. Jewett, vice-president, American Telephone and Telegraph Co.; Dr. Vernon Kellogg, permanent secretary, National Research Council; Charles F. Kettering, president, General Motors Research Corporation; Dr. Arthur D. Little, president, Arthur D. Little, Inc.; Dr. John C. Merriam, president, Carnegie Institution; Dr. Robert A. Millikan, chairman, executive council, California Institute of Technology; Dr. Henry Fairfield Osborn, president, American Museum of Natural History; Dr. Elmer A. Sperry, chairman, board of directors, Sperry Gyroscope Co.; Dr. Samuel W. Stratton, president, Massachusetts Institute of Technology; Dr. Elihu Thomson, director, Thomson Laboratory of the General Electric Co., Lynn, Mass.; Dr. Edward R. Weidlein, director, Mellon Institute of Industrial Research; Henry Herman Westinghouse, chairman, board of directors, Westinghouse Airbrake Co.; Dr. Albert E. White, director department of engineering research, University of Michigan; Dr. Willis R. Whitney, director of research, General Electric Co., Schenectady, N. Y., and Orville Wright, co-inventor of the airplane.

SCIENTIFIC NOTES AND NEWS

DR. THOMAS HUNT MORGAN, director of the Kerckhoff Laboratories of the Biological Sciences of the California Institute of Technology, Pasadena, was elected president of the American Association for the Advancement of Science at the close of the Des Moines meeting.

AT the 158th convocation of the University of Chicago, the degree of doctor of science was conferred on three chemists—Professor Moses Gomberg, Professor Gilbert Newton Lewis and Dr. H. A. Spoehr. The candidates were presented by Henry Gordon Gale, dean of the Ogden Graduate School of Science. The citations were as follows: Moses Gomberg, head of the department of chemistry, University of Michigan, "in recognition of his fundamental contributions to chemistry, especially in the discovery of free radicals, and in testimony of his leadership in the field of organic chemistry." Gilbert Newton Lewis, head of the department of chemistry, University of California, "in recognition of fundamental contributions to chemistry, especially in atomic and molecular structure, and in thermodynamics, and in testimony of his leadership in research in physical chemistry." Herman Augustus Spoehr, who received a Ph.D. degree from Chicago, and is now assistant director of the Coastal Laboratory of the Carnegie Institution of Washington, "in recognition of his fundamental contributions in the field of photosynthesis and in testimony of his leadership in the application of chemistry to botanical problems."

THE Edison medal, awarded by the American Institute of Electrical Engineers for "meritorious achievement in electrical science, electrical engineering or the electrical arts" has been conferred on Dr. Charles F. Scott, professor of electrical engineering at Yale University, for "his contributions to the science and art of polyphase transmission of electrical energy."

THE David Livingstone Centenary medal has been awarded by the National Geographic Society to Commander Richard E. Byrd. The Hispanic Society of America founded the decoration in 1913 with the proviso that it could be given only for "exceptionally important achievement in the field of geography of the Southern Hemisphere." Others who have received the medal include Sir Douglas Mawson, leader of the Australian-Antarctic expedition of 1911–1914; Theodore Roosevelt, for his discovery and exploration of the "River of Doubt," now known as Rio Roosevelt, and Colonel Rondon, for exploration of the Brazilian interior.

A RECEPTION and dinner dance was given to W. W. Skinner, assistant chief, chemical and technological research, U. S. Department of Agriculture, on December 4 to commemorate the completion of twenty-five years' service. On this occasion a silver token was presented to him by Dr. A. F. Woods, who spoke in appreciation of Dr. Skinner's work for the department. Dr. F. B. Linton presided at the dinner as toastmaster. The speakers were Dr. H. G. Knight, chief of the bureau of chemistry, who spoke of Dr. Skinner as a scientific man and administrator, and Mrs. M. T. Read, who spoke on Dr. Skinner as a man.

PROFESSOR WILLIAM MCPHERSON, dean of the Graduate School of the Ohio State University, became president of the American Chemical Society on January 1 as a result of the society's annual election.

Dr. McPherson will serve during 1930, succeeding Dr. Irving Langmuir, associate director of research of the General Electric Company. Dr. Moses Gomberg, professor of chemistry in the University of Michigan, was chosen president for 1931. In accordance with a recent change in its constitution, the society now elects each year a president and a president-elect, who serve in successive years. Professor James F. Norris, of the Massachusetts Institute of Technology, and Charles L. Reese, of the E. I. du Pont de Nemours and Company, Wilmington, Delaware, were elected directors for 1930–1932. The following are councilors-at-large: Edward Bartow, professor of chemistry, Iowa State University; Professor S. C. Lind, director of the School of Chemistry, University of Minnesota; Dr. Hugh S. Taylor, professor of physical chemistry, Princeton University, and David Wesson, consulting chemist, of Montclair, New Jersey.

At the thirty-sixth annual meeting of the American Mathematical Society, which opened at Lehigh University on December 26, Professor E. R. Hedrick was reelected president. The vice-presidents are Professor W. C. Graustein, of Harvard University, and Professor E. P. Lane, of the University of Chicago. The meeting next summer will be held at Brown University. The winter meeting will be held at Western Reserve University and the Case School of Applied Science. In the summer of 1931 the society will meet at the University of Minnesota.

Dr. Frederick C. Waite, professor of histology and embryology at Western Reserve University, has been elected president of the Ohio Academy of Science for the year 1929–30.

Princeton University announces the appointment of Dr. J. von Neumann, of the University of Berlin, and Dr. E. Wigner, of the Kaiser Wilhelm Institut für Physikalische Chemie, as visiting lecturers in mathematical physics for the second term of the present academic year. Dr. von Neumann and Dr. Wigner have both contributed to the development of modern mathematical physics, particularly in the theories of relativity and quantum mechanics, and during the past few years have collaborated in applying these principles to problems of molecular structure.

Dr. Ko Kuei Chen, known for his work on ephedrine, has become director of pharmacologic research of Eli Lilly and Company, Indianapolis.

Per K. Frölich has resigned his position as associate professor in chemical engineering and assistant director of the Research Laboratory of Applied Chemistry at the Massachusetts Institute of Technology, to join the staff of the Standard Oil Development Company, Elizabeth, N. J., where he will work on special research problems on petroleum.

Professor Alfred C. Lane, of Tufts College, and Professor Albert P. Brigham, of Colgate University, have been added to the staff of consultants of the Library of Congress.

Dr. T. Wayland Vaughan, director of the Scripps Institution of Oceanography at La Jolla, has been appointed to represent oceanography on the general subcommittee for geology of the Science Advisory Committee for the Chicago World's Fair of 1933.

Vicente G. Lava, associate professor of physical chemistry at the University of the Philippines, who has leave of absence, is visiting professor and Grasselli Research fellow at Oberlin College, working in colloid chemistry under Harry N. Holmes.

C. P. Buller has been appointed first senior observer in the solar physics observatory of the University of Cambridge.

Mr. and Mrs. Robert T. Hatt, of the American Museum of Natural History, have returned from a three months' expedition to Yucatan, where they collected recent mammals and reptiles and excavated fossils in the caves occurring in Yucatan's low mountains.

At the annual meeting of the American Society of Mechanical Engineers, Dr. Fred R. Low, editor of *Power;* Robert LeRoy Streeter, vice-president of the U. S. Aluminium Company; Harold W. Mowery, safety engineer with the American Abrasive Metals Company, and Edward J. Kearney, secretary and treasurer of the Kearney Trecker Company, were elected chairmen of the four standing technical committees, Power Test Codes, Research, Safety and Standardization, respectively.

A conference committee convened on December 12 and December 13, at the Missouri Botanical Garden, for the purpose of discussing methods for making cultures of wood-destroying organisms and specifically to discuss methods for determining toxicity relations of poisonous substances to wood-destroying fungi and type of conclusions which could be drawn after making toxicity determinations. The following were in attendance: Dr. Henry Schmitz, of the University of Minnesota; Mr. J. D. Burnes, of Page and Hill; Mr. Ernest Bateman, senior chemist of the United States Forest Products Laboratory; Dr. Carl Hartley, principal pathologist, and Dr. C. Audrey Richards, pathologist, U. S. Bureau of Plant Industry; Dr. R. H. Colley and Mr. R. E. Waterman, of the Bell Telephone Laboratories; Mr. C. S. Reeve, of the Barrett Company; Mr. S. R. Church, consulting engineer; Mr. E. B. Fulks, vice-president of the American Creosoting Company; Dr. A. L. Kammerer, consulting timber engineer, St. Louis; Dr. David H. Linder, mycologist, and Dr. Hermann von Schrenk, pathologist, Missouri Botanical Garden, St. Louis.

THE ninth series of Beaumont lectures of the Wayne County Medical Society, Detroit, will be given on January 27 and 28 by Dr. Wingate Todd, professor of anatomy in the Western Reserve University School of Medicine.

DR. CLARENCE E. MCCLUNG, professor of zoology and director of the zoological laboratory, University of Pennsylvania, will read a paper on "A Working Model of a Modern University" before the American Philosophical Society, Philadelphia, on January 3.

DR. H. H. WHETZEL, head of the department of plant pathology at Cornell University, addressed the instructional staff of the school of agriculture at the Pennsylvania State College on December 17.

DR. N. E. FORSYTHE, of the Nela Park Laboratories of the General Electric Company at Cleveland, Ohio, addressed the Physics Club of Philadelphia on December 13 on the "Physical Production of Ultra-violet Light."

PROFESSOR GARY N. CALKINS spoke before the New York Biology Teachers Association on December 20. He took for his subject "The Nucleus."

DR. C. M. YONGE, director of the Great Barrier Reef Expedition to Australia, recently gave a popular illustrated lecture on the work of the expedition before the Rutgers chapter of Sigma Xi at New Brunswick and before the Biological Seminar of Princeton University.

ON December 14, Dr. A. P. Coleman, professor emeritus of geology at the University of Toronto, delivered a lecture to the Royal Canadian Institute, on the subject, "The Last Million Years."

SIR RICHARD GREGORY, editor of *Nature,* gave an address on "Science and the Empire" at a joint meeting of the Royal Empire Society and the British Association for the Advancement of Science held at the Hotel Victoria on December 3. A brief address was also made by Sir Thomas Holland, president of the British Association.

THE American Association of Petroleum Geologists will hold their fifteenth annual meeting at New Orleans on March 20, 21 and 22, under the presidency of J. Y. Snyder, of Shreveport, Louisiana.

ON January 10 the first Chilean Congress of Pathology will meet in Concepcion with more than 600 delegates in attendance. An exposition of medical and sanitary products, technical books and publications will be held in conjunction with the congress.

A SPECIAL correspondent of the New York *Herald Tribune* reports that closer relations between the United States Department of Public Health and the Mexican Department of Health will be sought at the seventh Latin-American Medical Congress, to be held in Mexico City from January 12 to 19. Dr. Hugh S. Cumming, of the United States Department of Public Health, is expected to attend. Argentina, Peru, Brazil, Chile, Cuba and San Salvador will send delegates, and all other Spanish-American countries are expected to be represented. The congress in January will be the first held since 1922 in Latin-America. It is expected that President Emilio Portes Gil, of Mexico, will open the convention. In conjunction with the congress the second National Hygiene Convention of Mexico will be held. Also there will be a scientific exposition, in which the School of Medicine of the University of Mexico, the Federal Department of Health, the Public Charities and the Military Medical School will take part.

THE Commonwealth Fund has made an additional appropriation of $27,000 to continue a series of psychiatric fellowships at the psychopathic hospital at the University of Colorado School of Medicine, Denver. Six fellows are now in training. The new appropriation will make possible the appointment of three more in 1930 and three more in 1931 for periods of two years.

AN Institute of Paper Chemistry, a graduate school for the training of chemists in the pulp and paper industry, has been established at Lawrence College, Appleton, Wisconsin. The institute, which has been organized as an affiliated institution, has the support of ninety per cent. of the paper mills of Wisconsin and will be controlled by a board of trustees representing the college and the participating mills. President Henry M. Wriston is director of the new organization, Dr. Otto Kress, paper chemist, is technical director, and Ernest Mahler, vice-president of the Kimberley-Clark Paper Company, president of the board of trustees. Appropriations sufficient to meet an annual budget of at least $60,000 have been assured the college by the paper manufacturers. It is planned to open the institute in February, 1930. Two fellowships with annual stipends of $500 each have been endowed for the institute by the Paper Makers Chemical Corporation, manufacturing chemists. The fellowships, which will be available with the opening of the institute, are to be awarded to students showing suitable qualifications for the advanced work of the graduate school.

A SERIES of conferences for the purpose of helping freshmen in their choice of a major engineering course has been announced by Dean Paul Cloke, of the College of Technology of the University of Maine. The conferences will begin at once and extend through January and February. The following topics will be discussed in order: Engineering Studies, Experiences in Engineering, Chemical Engineering, Civil Engineering, Electrical Engineering, Mechanical Engineering, Relation of Athletics to College Life, Student Life. The discussions will be led by the dean, the department heads and the faculty manager of athletics. Although designed for freshman engineering students, the conferences will be open to all who are interested, especially those who are having difficulty with their work.

UNIVERSITY AND EDUCATIONAL NOTES

AN anonymous gift of $100,000 to the University of California has been received for the support of research in cancer and allied subjects by the medical school and the Hooper Foundation for Medical Research. With the addition of this fund, the university will have a total endowment of $200,000 for research in this field. Mr. and Mrs. George H. Roos, of San Francisco, recently made a gift of $100,000 for research in thoracic surgery and cancer, and later added $5,000 for the equipment of a clinic and research laboratory to carry on this work.

THE late Abraham Rosenberg, San Francisco merchant, who was a leader in developing world markets for California dried fruits, has included in his will a bequest of $100,000 to the University of California as an endowment for the support of graduate research fellowships.

IN honor of Martin J. Insull, of Chicago, Mrs. Insull has founded and endowed with $25,000 a scholarship in the college of engineering of Cornell University, from which Mr. Insull was graduated with the degree of M.E. in 1893, and in which he is himself building up a loan fund for the benefit of students. The new scholarship may be held for four years and during that time will pay most of the scholar's expenses at college, amounting, at the present rate of tuition, to an average of more than $1,000 a year.

IT is announced that in accordance with the wish of Dr. Joseph S. Ames, who recently succeeded Dr. Frank J. Goodnow as president of the Johns Hopkins University, there will be no formal inauguration ceremonies.

THE resignation is announced of Arthur Edward Wells, professor of metallurgy at Harvard University.

DR. BENNO EDWARD LISCHER, of the University of Michigan, has been appointed full-time professor of orthodontics in the University of California.

DR. KENNETH GOODNER has been appointed instructor in bacteriology and immunology in the School of Public Health at Harvard University.

AT the University of Cambridge, C. F. A. Pantin, of Trinity and Christ's Colleges, has been appointed university lecturer in zoology, and J. E. E. Craster, of Downing College, has been appointed university lecturer in geography.

DISCUSSION

SUPERFLUOUS PUBLICATIONS

THERE appears to be an increasing tendency for the publication of journals devoted to exploitation of work by individual laboratories and organizations promoting an extended program of research on varied subjects. There are dozens of institutions where the amount of manuscript produced per year is amply sufficient to fill the pages of a weekly, monthly or quarterly journal so that a reasonable temptation on the part of the executives of these institutions may readily exist for the independent maintenance of an organ of publication. It is doubtful, however, if the publicity so secured reacts favorably toward the organization concerned.

Usually such a journal is a hopeless compilation of reports on almost every subject known to science. A short article on atomic physics may be buried between a memoir on the physical properties of concrete and a report on the design of an aeroplane propeller. For continuity, the Encyclopaedia Britannica is to be preferred.

A serious problem confronts the librarian in the cataloguing and disposition of these publications, especially in universities where reference libraries are divided and allocated to the various departmental offices. Institutions devoted to a restricted subject are forced to subscribe to a journal containing numerous articles on material of little interest in order to have on file a few papers of immediate importance. Often the smaller institutions will not subscribe to the journal and papers of importance to it are lost except through the courtesy of the particular authors in distributing reprints. The miscellaneous character of such journals is also responsible for inadequate review of their contents by the various abstract journals. Many papers so published have not been abstracted and accordingly are unknown in the bibliography of the particular subject concerned.

The research investigators in institutions maintaining private publications recognize the handicap to which they are subjected and desire to submit their reports to a medium of publication primarily concerned with papers of a similar character. If such a policy is permitted, however, the privately printed journal either dies a natural death, as it should, or continues its existence as a collection of articles reprinted from the many technical journals devoted to specific subject-matter. As few executives will subscribe to the policy of the publication of a mere collection of reprints, since this is too obviously an extravagant procedure, it is usually necessary, for the very existence of the private journal, that the employees of the laboratory concerned be required to submit their papers to their own journal for prior publication. In general, society publications are at liberty to reprint such material, but their editors likewise feel that the extravagant policy of publishing the same article in two journals should not be encouraged. Most of the large society-controlled journals for this reason require that their editors accept no paper for publication which has appeared in any other medium.

The menace of the private journal has another far-reaching influence. Many societies already claim ownership to the written report of investigations presented before their stated meetings, and this policy can be and, with the continuance of private journals, must be more rigorously extended and enforced. The society journal is the center at which the activities of an organization concentrate. It is the duty of each member of a society to see that his particular journal is given every possible support. An institution which enforces prior publication in a private journal therefore acts contrary to the best interest of the national organization and in many cases prevents its personnel from playing an active rôle in the national and cooperative development of research. In this way the privately printed journal defeats the very purpose for which it is supposedly sustained. It fails to secure adequate publicity for its own work and its maintenance militates against the national recognition of its contributors who may be barred from participation in the national meetings and from honors which might otherwise be extended.

About the only excuse for a private journal is that it serves as a means for the publication of extended memoirs which would be rejected by society-controlled journals. Two reasons may occur for such a rejection. The paper may contain a large amount of superfluous material which could have been readily omitted in which case it might have been acceptable. Often a lengthy paper will be read by possibly ten or less interested individuals, and an abbreviated account of importance to a larger group of readers could be published in a recognized journal with a statement to the effect that mimeographed copies of the complete report with numerous data are on file for loan by the author's institution. On the other hand, it may rarely occur that the publication of an extended manuscript is highly desirable but because of the excessive cost funds are not available for its appearance in a society journal. The work might then well appear as a separate brochure or the institution concerned could make arrangements with the society journal to defray a part of the cost of publication. This latter plan has been successfully adopted by several recognized journals and research laboratories.

Present regulations, possibly instigated by the Government Printing Office, do not permit the participation of government laboratories in such a program, but if the majority of the scientific public were convinced that curtailing of the numerous *heterogeneous* government journals and the distribution of the material in national journals of homogeneous character were conducive to the scientific welfare of the country, it is quite possible that the iron-clad restrictions now existing could be partially removed.

In conclusion the writer wishes to emphasize that a large group of scientists in this country is convinced of the detrimental influence of privately published journals containing material of heterogeneous character, and the same objection, but with less serious consequences, applies to most academy proceedings. It would seem that the subject is of sufficient importance to warrant careful consideration by the governing boards of organizations and societies devoted to broad fields of research.

PAUL D. FOOTE

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FLAGELLUM DIVISION IN PARANEMA GLOBIFERUM

OWING to the fact that there prevails no little skepticism about the splitting of the flagellum in division of the Mastigophora, this observation is reported.

It is often rather difficult in our laboratory to obtain Euglena when desired, but another mastigophoran is very often used as a type because it is easily obtained in our cultures. This is *Paranema globiferum* (determined by Dr. R. W. Hegner, of Johns Hopkins), and the processes here described have been observed many times.

The first evidence of the beginning of longitudinal binary fission in these protozoa is the appearance of a forked flagellum. The forking increases until the organism appears to be biflagellate. Division of the body then begins, the gullet splits and in from five to ten minutes the new individuals separate and proceed in search of food which, under our observation, consisted of small algae (*Ophiocytium capitatum*).

CLYDE T. REED

TEXAS COLLEGE OF ARTS AND INDUSTRIES

A NEW GUINEA EEL-FAIR

The ascent of fresh-water streams by vast swarms of elvers or young eels, long known as "eel-fairs" in England, is a phenomenon of great interest. The migrations of the Atlantic eels are now well known, thanks to the studies of a long line of naturalists, culminating in the epochal researches of Johannes Schmidt.

As yet little is known of the life histories of the numerous species of Anguilla found in the Indo-Pacific waters. It is therefore of interest to note that on May 24, 1928, we found an incredible number of young eels ascending the great Sepik River at Marienberg, New Guinea, which is about forty miles inland from the north coast. This is in former German New Guinea.

I measured 262 specimens, varying from 104 to 210 mm in length. Most of the eels observed were from 125 to 150 mm long, and quite slender. A moderate increase in length was accompanied by a very great increase in bulk.

The eels occurred in such numbers that the natives, men, women and children, scooped them up out of the river by basketsfull on both sides of the river. The Sepik at Marienberg is half a mile wide and fifteen to twenty-five feet deep at the bank; our ship, drawing thirteen feet of water, tied up to the shore.

Two days later only a few individuals were found in seining the tributary brooks where the young eels had occurred in myriads before.

This is the second eel-fair observed in New Guinea, the first seen being on February 22, 1922, in the Mamberamo River, Dutch New Guinea. This was inland a considerable distance from the north coast.

Albert W. Herre

Stanford University

SCIENTIFIC APPARATUS AND LABORATORY METHODS

MORE ABOUT LACTOPHENOL

In two late numbers of Science[1] two contributors have called attention to lactophenol and its use. Lactophenol and lactophenol gum have been used for nearly eight years by the writer, his coworkers and students in the department of botany. This solution has been found an excellent medium for killing, staining and mounting microscopic materials, for these three processes may be accomplished in one process with green lactophenol.

However, for staining nuclei and differentiating hyphae in plant tissues, as wood and parenchyma, the sections were first submerged for ten minutes in lactophenol to which two parts of distilled water had been added; after this liquid was drained or blotted from the sections they were covered with deep acid green lactophenol and stored overnight in the open air. The liquid was again removed, the sections washed by floating clear lactophenol over them and then mounted in clear lactophenol or lactophenol gum. Hyphae in cells of fruit, wood and from germinating conidia were nicely differentiated by this method.

As investigators continue to employ this solution in zoological and botanical work, greater possibilities for a more extensive use may be forthcoming. If such be the case, they should be published for the benefit of all.

Details for the preparation of lactophenol and lactophenol gum together with references may be found in an article by W. H. Davis, "Lactophenol."[2]

W. H. Davis

Massachusetts Agricultural College

SPECIAL ARTICLES

A NEMATODE PARASITE OF THE JAPANESE BEETLE (POPILLIA JAPONICA NEWM.)

On May 29, 1929, at the Tavistock Golf Course, Haddonfield, New Jersey, in a plot of ground two feet square the writers found fourteen dead, fully grown Japanese beetle grubs. These grubs were flaccid and of an ocherous brown tint. On dissecting the cadavers each one was found infected with numerous nematodes. Among these nematodes ovoviviparous females, males and larval forms were observed. On May 31, in the identical locality, nine more dead Japanese beetle grubs were found. These grubs had the same external appearance as the previous ones and were also heavily infested with the parasite.

On each of the two days following this observation eight fully grown Japanese beetle grubs from healthy stock were experimentally infected with worms derived from the parasitized grubs. One grub was placed in each of eight sterile tin salve cans containing soil which had been previously baked. The surface of the soil in each can was dampened with five drops of a heavy salt solution suspension of the nemas. An equal number of uninfected controls were held. Within five to seven days fifteen of the sixteen infected grubs died. They were flaccid, of an ocherous brown color and were filled with the introduced nematodes. One infected grub and the sixteen controls pupated and transformed. This experiment was repeated towards the last of June with approximately identical results.

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[1] Science, 70: 430, November 1, 1929; 70: 455, November 8, 1929.

[2] *Botanical Gazette*, 77: 343–344, 1924.

During the course of the first experiments some of the worms derived from the May 29 and 31 field collections were fixed and sent, on June 4, to Dr. G. Steiner, of the U. S. Department of Agriculture, for identification. Dr. Steiner informed us that the nematode was undoubtedly a parasite and not a saprozoic free-living form. It belongs to the family *Oxyuridae*, and has been described by Dr. Steiner as a new genus and species under the name of *Neoaplectana glaseri*.[1] Whether *Neoaplectana* accompanied the Japanese beetle to this country or is a usual parasite of some native insect, from which it has reached *Popillia japonica*, is not yet clear.

During the summer and early fall frequent examinations of living and dead grubs were made. Some of these were obtained from the original locality as well as from other sources in New Jersey and Pennsylvania. However, *Neoaplectana* was found in only one place, namely Tavistock, near Haddonfield. On June 15, one pupa from this station was found parasitized with *Neoaplectana*. On June 21, a reexamination of the small plot of ground where the nematodes were first found yielded three Japanese beetle grubs, two pupae and two adults, all parasitized. The adults seemed to have been in the process of emerging from the soil when stricken. The June 21 collection was the last *Neoaplectana*-parasitized material obtained. After this date the adults emerged and the next generation of grubs were too small and scarce for satisfactory work until about the last of August.

One dead second-stage larva obtained from Pitman, New Jersey, August 24, and three from Haddonfield September 17, were heavily infested with several species of nematodes that appeared smaller than the spring parasite. These nematodes were undoubtedly saprophytes which multiplied within the bodies of the grubs after they succumbed from other causes. We were able to cultivate several generations of these worms on hay infusion agar to which a small amount of coagulated horse serum had been added. The females of these worms laid eggs very freely on the medium. Healthy Japanese beetle grubs infected with these nematodes did not die, although they acquired the worms, probably per os, and maintained from one to six of them within their alimentary tracts for about two weeks. The saprophytic species were the only ones found throughout the early autumn, and they also apparently disappeared from the field after the middle of October.

Neoaplectana appears to be ideally adapted as a parasite for the Japanese beetle, for the reason that the host spends most of its long life cycle in the ground, which is undoubtedly also the natural environment of the nematode during at least a portion of its existence. According to present indications the parasite still occurs locally. However, it possesses great reproductive and lethal capacities, and therefore might prove a valuable adjunct if distributed throughout the territory infested with the Japanese beetle.

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REVERSAL OF THE STIMULATING ACTION OF HYDROSTATIC PRESSURE ON STRIATED MUSCLE

THE application of hydrostatic pressure to striated muscle commonly results in a marked augmentation of the tension developed during a single twitch.[1] Pressures of the order of 1,000 pounds per square inch in our previous study caused an increase of about 30 per cent. in tension and heat production. Most of our work, however, has been carried out on cardiac muscle in which tissue the effects of pressure are greater and the results may be predicted with considerable confidence.[2] Certain observations made in the interim on striated muscle failed to show as great a stimulation as was reported earlier, and occasional preparations were entirely uninfluenced by pressure. A further study has therefore been undertaken on striated muscle in which the effects of various environmental factors have been investigated in relation to the magnitude of the response under pressure. The results, a preliminary report of which is here published, are of interest in relation to the theories of pressure action and to the general problem of muscular contraction.

All observations have been made on sciatic-gastrocnemius preparations from the frog by a technique previously described.[1]

When the muscle was immersed in an oxygen free Ringer's solution or in one in which the acidity had been increased to about a pH 6.8 by the addition of hydrochloric acid, a characteristic change was noted. At first pressure resulted in the usual augmentation in the response of the muscle, but after successive applications of pressure there was no increase in tension above the control value. It was further observed that if a muscle, when immersed in an oxygenated normal Ringer's solution, was fatigued by repeated stimulation, its response under pressure was less than the control, *i.e.*, the action of pressure on the tension developed by the muscle in response to a single stimulus is opposite in direction to its action in a fresh preparation. It seems probable that oxygen lack and acid solutions produce their effects by promoting fatigue. The following points have been established regarding the reversal of the pressure effect in the fatigued muscle: (1) The degree of depressed is roughly proportional to the pressure employed. (2) The tension developed by the fatigued muscle is commonly reduced to about one half by a pressure of 1,600 pounds per square inch. (3) The response very quickly, possibly instantaneously, returns to the control value when the pressure is released.

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[1] *J. Wash. Acad. Sci.*, 19: 436, 1929.

[1] McKeen Cattell and D. J. Edwards, *Am. Jour. Physiol.*, 86: 371, 1928.

[2] D. J. Edwards and McKeen Cattell, *Am. Jour. Physiol.*, 84: 472, 1928.

In the case of cardiac muscle the stimulating action of pressure on the tension can no longer be obtained when the temperature is reduced to 5° C., and we have secured some evidence of a reversal occurring at that point. (In press, *American Journal of Physiology.*) Studies now in progress on striated muscle indicate that there is a critical point at approximately 13° C. at which the stimulating action of pressure passes into depression. At a few degrees below this temperature the depressive action becomes marked and becomes greater as the pressure is increased. A few preparations have shown, in the vicinity of the critical temperature, a stimulation under the lower pressures (1,000 pounds) and depression at higher pressures (2,100 pounds). As the temperature is lowered pressure causes a further reduction in the response until at about 1° C. high pressure (2,100 pounds) almost completely suppresses the development of tension. At room temperature the magnitude of the response of the muscle continues to increase with increasing pressure up to at least 2,100 pounds per square inch, which is the greatest pressure we have employed.

When pressure is released the muscle again responds with the development of tension, the record differing in no way from the control taken before the application of pressure to the cold muscle. When such a muscle is warmed to room temperature, pressure once more causes an increase in the development of tension corresponding closely with the result obtained before the muscle was chilled.

Measurements of the duration of the phases of contraction and relaxation of cardiac muscle show that moderate pressures result in only a slight prolongation of these periods, and the same appears to hold for striated muscle at room temperature. On the other hand, at the lower temperatures pressure causes, along with the depression in tension development, a striking prolongation in the duration of the phases of contraction and relaxation which, for the higher pressures, may reach 100 per cent.

Certain interesting differences of behavior between cardiac and striated muscle are indicated by these results. In the first place, it appears impossible to fatigue cardiac muscle in such a manner as to produce a reversal of the pressure effect such as occurs in striated muscle, and in the second place the critical temperature, in which reversal of the pressure effect occurs, is about 8° C. lower in cardiac muscle.

The significance of these results in relation to the mechanism of muscular contraction will be discussed at a later date in connection with the publication of the complete data.

SUMMARY

The usual augmenting action of pressure on the tension developed by striated muscle in response to a single stimulus changes to depression on fatiguing the muscle. On release of the pressure the tension of the single twitch again reaches the control value.

A similar reversal may be brought about by cooling the muscle, the change usually occurring at about 13° C. Below this temperature the depression is roughly proportional to the pressure. At about 1° C. the tension development may be completely inhibited by high pressure. The muscle responds normally upon release of the pressure, and upon warming pressure again causes augmentation of contraction.

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BOOKS RECEIVED

ALEXANDER, JEROME. *Colloid Chemistry.* Pp. x + 270. Third edition. Van Nostrand. $3.00.

GATES, R. RUGGLES. *Heredity in Man.* Pp. xiii + 385. 87 illustrations. Macmillan. $

ISABEY, JEAN. *Cours de Chimie.* Pp. 393. Illustrated. Gauthier-Villars. Paris. 70 fr.

LIDDELL, E. G. T., and CHARLES SHERRINGTON. *Mammalian Physiology:* A Course of Practical Exercises. Second edition. Pp. xi + 162. Oxford University Press. $5.50.

RITCHEY, G. W. *The Development of Astro-Photography and the Great Telescopes of the Future.* In French and English. 34 plates. Société Astronomique de France.

SMITH, T. V., and LEONARD D. WHITE, Editors. Chicago: *An Experiment in Social Science Research.* Pp. xi + 283. University of Chicago Press. $3.00.

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PERMANENT ELEMENTS IN THE FLUX OF PRESENT-DAY PHYSICS[1]

By Professor P. W. BRIDGMAN

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MANY of us could, I believe, confess to a feeling of breathlessness at the rapid changes of our present physical progress, and some of us might even, in a moment of candor, admit a little resentment at our shortness of breath. Let us discuss together what we may perhaps best do to recover our poise.

The changing situation which is responsible for our discomfort is complex. First and foremost there is our changing experimental knowledge, reaching over the entire range from the infinitely small to the infinitely large. The upsetting feature here is not so much that we have discovered an enormous array of new facts, which in themselves are difficult enough to keep pace with, as that these facts have proved in many cases to be irreconcilable with our previous expectations of what was possible, so that we have been forced to change our entire conceptual attitude. These conceptual changes have in many cases been associated with mathematical theories, which are being continually formulated at an ever-accelerating tempo and in a complexity and abstractness increasingly formidable. Some of the more important landmarks in this progression are: The electromagnetic theory of light, the special theory of relativity, the general theory of relativity, the quantum theory of Bohr, the matrix calculus of Heisenberg, the wave mechanics of Schrödinger, the transformation theory of Dirac and Jordan, the group theory of Weyl and now the double quantization theory of Jordan and others.

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[1] Address of the retiring vice-president and chairman of Section B—Physics, American Association for the Advancement of Science, Des Moines, Iowa, December, 1929.

These have come crowding on each other's heels with ever-increasing unmannerliness, until the average physicist, for whom I venture to speak, flounders in bewilderment.

Are there not some general principles disclosed in all this welter of mathematical reconstruction in which the average physicist may find a sense of comparative peace, of some security that his endeavors to reconstruct his conceptual attitude will not have to begin over again next week and of some assurance that his program of future activity lies along lines of real significance?

One very broad generalization from past experience is that whenever we extend the domain of experiment we must be prepared for unexpected new facts. If we whole-heartedly accept this generalization as of real significance, important conclusions follow which apply to both our experimental activity and our conceptual outlook. On the experimental side it follows that every real extension of our present experimental range is worth while and necessary. An increase of accuracy of measurement constitutes an increase of range, so that any one who can increase the precision of any sort of measurement makes an important contribution. Not every one may be interested to increase by a factor of ten the precision of weighing, for example, but there are persons to whom this sort of refinement is congenial, and who can now pursue the line in which they are most skilful, while the others of us can enthusiastically applaud their skill.

Further, in formulating to ourselves what the present situation actually is, we should cultivate a more deliberate self-consciousness of the accuracy of our present experimental knowledge. This should get into our courses of instruction, certainly into those for our graduate students if not into the elementary courses. We should all know the limits of accuracy obtainable, for example, in measuring a length or a weight or an interval of time or a temperature; we should know how accurately the inverse square law of gravitation has been established, or how accurately the gravitation constant or the velocity of light or the gas constant has been determined.

Our point of view gives added importance not only to every increase of precision but also to other sorts of increase of the experimental range, and those who take a constitutional satisfaction in pushing our experiments to higher temperatures or to higher electric or magnetic fields or to higher pressures or to higher light intensity or to higher gravitational or accelerational fields may feel a renewed sense of the importance of their contribution. But although experiments over greater ranges or with increased precision acquire an increased importance, it does not follow that all results here are equally interesting or significant, or that the prospective experimenter can expect to make his choice with his eyes shut and be awakened by the knocking of the postman bearing the Nobel prize. The postman is more likely to knock at the door of the man who in extending our range reaches qualitatively new effects, such as the wave-like structure of matter.

On the conceptual side, perhaps the most important principle disclosed by our continual discovery of strange new facts whenever we extend the domain of experiment is that the actual experimental world transcends all our efforts to get into perfect mental contact with it. We must by now feel that it is a little naïve continually to hope that our last theoretical formulation will prove to have arrived at the long-sought goal, when in the past our hopes have been continually shattered by each new discovery. Acceptance of this situation carries with it the conviction that in the last analysis any adequate scheme of geting into touch with experiment can be only descriptive, for no theoretical scheme of explaining nature can be regarded as secure until verified by every possible experiment, and when every such possible experimental check has been applied, the theory degenerates into a description. The fact that every acceptable description of nature is rational might at first be thought to have some deeper significance, but I believe that analysis will show that this means simply that we refuse to accept any description which is not framed in such terms as to be adapted to our mentality, a requirement so inevitable as to be almost without significance.

Another suggestion which may be of value in our search for elements of stability in our attitude is afforded by our ever-increasing appreciation of the importance of the unavoidable subjective element in any account which we can give of our experience. We used to demand that the ultimate goal of physical theories should be nothing less than the discovery of the underlying realities. To-day our demand for reality is much less insistent, in large part because we are much less confident that the ultimate reality, which we thought to be our goal, has any meaning. The meaning to be attached to reality is to a large extent a personal matter and changes with time, but I believe it is fair to say that the sense in which every one used reality a few years ago and the sense in which the majority use it to-day has "uniqueness" as a minimum connotation. It would not have been admitted that two entirely different explanations of the universe could each be equally real, but to-day we see that uniqueness in an explanation is an impossible ideal, and the quest for reality, in so far as reality connotes uniqueness, must be abandoned as a meaningless quest. A sufficient basis for this change of attitude could be found in the proof of Poincaré that any aggregation of phenomena, no matter how complicated, is always susceptible of an infinite number of purely mechanical explanations. The reason that we are not interested in giving an explanation of quantum phenomena on a purely mechanical basis is that any such explanation would involve the assumption of a prohibitively complicated amount of detail concealed beyond the reach of any contact with experiment. It is natural, therefore, to find that the demand that our theories reproduce reality is becoming replaced by the demand of convenience and simplicity. Another requirement in a satisfactory theory has recently been much emphasized by Heisenberg and his school, namely, that our theories should contain only observable quantities. This involves so modifying the concept of reality as to make it closely associated with the possibility of direct observation. But although this alternative formulation of the reality concept has at first a most satisfying aspect, I believe that in the actual working out it is less satisfactory than in anticipation. In fact, I am inclined to think that Heisenberg's demand that only observable quantities enter the theory played only a suggestive rôle in leading to one of the many possible solutions and was as sterile in actually compelling the adoption of his form of theory as was the corresponding demand of Einstein that the law of gravitation be written in an invariant form. For if one examines how the principle works in practice, it will be seen that all that is demanded is that the raw material which is fed into the calculating machine and the final results which are taken out shall connect with direct observations. All the intermediate processes and operations, the internal pistons and gears of the theory, have as much the character of pure inventions as anything which Poincaré might have proposed. However much one might have been inclined fifty years ago to see some warrant for ascribing physical reality to the internal processes of a theory because of its success in meeting the observed situation, certainly no one of the present generation will be capable of so naïve an attitude after our illuminating experience of the physical equivalence of the matrix calculus and the wave mechanics.

As a consequence of all this, the attitude of the physicist to-day is changing toward mathematical theory. As a whole, he takes it far less seriously, recognizes that it contains less of reality and more of a purely suggestive character than he had realized, and lays more emphasis on the demands of simplicity and convenience. There are puzzling questions to be answered and instinctive reactions to be overcome in adopting this point of view. It is hard to resist the conviction that there is some deep underlying significance in the fact that the mathematical operations of the matrix calculus of Heisenberg, for example, make such wonderful contact with experiment. But what the precise significance of this may be eludes formulation, and in the meantime the physicist must fortify himself with somewhat skeptical considerations like the following:

> On the one hand, mathematics is a study of certain aspects of the human thinking process; on the other hand, when we make ourselves master of a physical situation, we so arrange the data as to conform to the demands of our thinking process. It would seem probable, therefore, that merely in arranging the subject in a form suitable for discussion we have already introduced the mathematics—the mathematics is unavoidably introduced by our treatment, and it is inevitable that mathematical principles appear to rule nature.

What do these general considerations have to do with our program of action. In the first place, we are going to be exceedingly cautious in ascribing any finality to the details of the present mathematical theories. There is among the younger and more enthusiastic members of the physical community a tendency to regard the present theories as final which the more sedate members must combat, even in the face of all the successes of the present theories. One of the most certain lessons of the past is that no amount of success in the youth of a theory is any guarantee of a hale and hearty old age; this is to be expected and is a consequence of the transcendence of nature. Against this view, an enthusiastic protagonist of the new theories might with considerable justification, I believe, urge that there are certain elements of genuine novelty in our present outlook which offer a basis for the belief that we may be on the point of breaking away from our often-repeated cycles of revision and reformulation. But although there may be distinctly encouraging signs of a brighter future, I believe that nevertheless there are specific elements of weakness in the present situation which justify the suspicion that our present theories still need thoroughgoing modification. Perhaps one of the most serious weaknesses of the present theory is the way in which it deals with static effects. One important consequence of the Heisenberg principle is that an electron can not stand still, yet a potential energy is substituted into the fundamental equations of the theory which retains the old fiction of an inverse square force emanating from a stationary center, and which palpably has no meaning in terms of direct experiment. Such a thing is entirely opposed to the spirit of our new outlook. We are to expect that presently the apparently static inverse square law of force will be described in statistical terms. Another suggestion that the present theory marks only a half-way stage of progress is to be found in its treatment of the universal constants, such as the gravitation constant, the velocity of light, the charge and the mass of the electron and the quantum h. No one, I suppose, is yet so pessimistic as to give up the hope that eventually we will be able to give an account of these constants, instead of always having to carry them in our equations as elements imposed from without. One may also hope to have sometime a theory of the equality of the charge on proton and electron.

Perhaps these misgivings about the permanence of our present theories seem of too vague and general a character to be of much significance, but I believe that in the past we have been many times too willing to forget any very broad general objections to which our theories may have been subject, in our satisfaction with their success in dealing with fairly wide classes of special phenomena. For example, the fact that the classical principle of equipartition of energy demanded that the atoms be mathematically rigid should in itself have been sufficient to show that any attempt to reduce all action to pure mechanics was certain to fail.

All this must not be allowed in any way to minimize our conviction of the very great importance of carrying through the analysis of all possible consequences of our many new mathematical points of view, but it does suggest that many physicists who are not professionally interested in making new contributions to new mathematical developments, but rather want to understand what there is of permanent significance in present developments, may with a clear conscience omit to work through the details of much of recent mathematics, in the conviction that it is of more or less transient character. But apart from the mathematical details, and perhaps sometimes not intimately connected with them, there are certain broad qualitative points of view characteristic of the new theories which every physicist should grasp and incorporate into his thinking. Perhaps the two most important ot these points of view are (1) that the measurable properties of electrons embrace some phenomena which we find convenient to describe in terms of the wave phenomena of ordinary experience, in addition to the older and more familiar phenomena which we have satisfactorily dealt with in terms of a particle picture; and (2) that there is some essential limitation to the sorts of measurement that can be made simultaneously on elementary things, which is formulated in Heisenberg's principle of uncertainty. In speaking of these points of view as two I do not wish to imply that they are not logically connected, for they are very intimately related.

It is possible to direct just criticism at the mathematical deduction of these two principles from the logical premises. The wave mechanics is open to various objections, one of the chief of which to my mind is that it provides no way of dealing with transient phenomena; this fact constitutes to a certain extent a failure of the fundamental principle, for it is only transient phenomena which are directly observed. Further, the deduction of the Heisenberg principle as a necessary consequence of the fundamental assumptions has failed to satisfy many and does indeed seem to contain a certain feature inserted arbitrarily into the theory. But I believe that in spite of these criticisms these two points of view transcend the mathematics by which they were derived, and that, inspired and guided by the mathematics, we have come upon a point of view which is of more permanent value than the mathematics itself.

These two points of view, if I understand correctly the claims made for them, should be sufficient, in conjunction with other physical knowledge which we already have, to determine the nature of the elementary processes and entities which analysis of our physical experience discloses to us. Here we reach the actual frontiers of physical exploration, and doubtless the most fundamental problem confronting us is to acquire understanding of these things. The more complicated things, such as the chemical properties of molecules, involve processes of mathematical synthesis which we need not expect to grasp intuitively and which will not be completely worked out for some time in the future, but of the qualitative nature of the underlying elemental processes and entities all physicists should now attempt to acquire some intuitive command. Since the new theories are formulated so as to be consistent with the cardinal principle that the properties of a thing have no meaning which is not contained in some describable experience, our intuitions should be able to tell us what to expect in various experimental situations involving elementary things. This does not mean that the experience in terms of which our intuition thinks is necessarily an experience so closely connected with actuality that we could go into the laboratory and make the experiments, but the experiments must be such as are allowed in principle by the new theories. For instance, we can conceive ourselves in principle determining the frequency of a single photon by finding the location on a photographic plate of a single developed grain exposed in a spectroscope of infinite resolving power, although we may perfectly well recognize that to make such a measurement is beyond our present experimental skill. Our intuitive grasp of an elementary situation may, then, be tested by our ability to describe what to expect in terms of conceptual experiments. I believe that in the devising and discussing of such conceptual experiments there is an important field which may be cultivated, particularly at the present time, with much profit. It should be possible to build up a formal structure in which the properties of photons and electrons and other elemental things, such as quantum interactions, are described in terms of conceptual experiments, and from simple properties deduce more complicated properties in much the fashion of Euclid. In fact, the resemblance between this ideal and Euclid is a rather close one, for that part of the analysis of Euclid which consists in moving figures about and comparing them by superposition amounts to nothing more than conceptual experiments with geometrical figures. A systematic development of the conceptual experiment would be found by many, I believe, to give a more illuminating insight than a painful acquisition of the details of the present mathematical picture.

As suggestive of what may be done here, I append a list of questions which are to be answered in terms of conceptual experiments allowed by the new point of view.

(1) Are experiments on single "naked" electrons possible? How may one be sure that he has a single electron in his apparatus? Are there any methods of detecting the presence of an electron that do not demand that the electron be traveling with fairly high velocity? Can a stationary electron be detected?

(2) How may the charge of a single electron be measured? Is there any theoretical limit to the accuracy with which a single measurement of charge may be made? Or is an accurate value of e obtainable only from statistical measurement?

(3) What is the evidence that an electron has independent existence in empty space? May one electron stream receive a deflection on impinging on another?

(4) Is the equivalence of the charge on electrons and protons a statistical or an individual effect? How accurately may the charge of an individual electron and proton be proved equal?

(5) How may the magnetic moment of a single electron be found?

(6) What properties may an electron have simultaneously? We know that it can not simultaneously have position and velocity. May the charge, the mass, the momentum and the energy be simultaneously determined?

(7) Is a single electron subject to a gravitational field?

(8) To what extent does an electron have identity? May it be observed continuously, or is there a minimum time between successive observations?

(9) How do the measurable properties of an electron in those places where, according to the wave mechanics, the kinetic energy is negative differ from those of a classical electron?

(10) How may the frequency of a single photon be measured?

(11) May the frequency of a single photon be measured without at the same time compelling it to have some direction, that is, are frequency and direction independent properties?

(12) May the energy of a single photon be measured independently of its frequency?

(13) Does a single photon have a plane of polarization, that is, may the plane of polarization of a single photon be measured? (I have been able to discover no method of doing this.)

(14) Can the velocity of a single photon be measured? All experimental determinations of the velocity of light have been essentially measurements on a steady state.

(15) What experimental method is there of detecting the motion of a single photon?

(16) How many properties does an individual photon have simultaneously? For example, may the velocity, the frequency, the direction, the momentum and the energy be measured simultaneously?

(17) Does a photon have independent existence in empty space? Can two crossed streams of photons be made to disturb each other?

(18) To what extent does a photon have identity?

(19) Is there any method by which the emission of a photon from an atom may be detected which does not involve receiving the emitted photon?

(20) What sort of a constant is h? May it be determined from a single quantum process, or is it essentially statistical? The six methods for determining h listed by Birge are all essentially statistical.

(21) Is there any evidence that two quantum processes ever interfere with each other, or that one begins before the other has ended?

It will very probably be found that the answers to some of these questions can not at present be given without a rather intimate acquaintance with mathematical theory, but I believe that this is merely a temporary phase and that ultimately we shall be able to demand that our theories be so formulated that we can answer these and other questions intuitively without recourse to formal mathematics. In the meantime, I believe that any one who attempts to devise the conceptual experiments by which these questions may be answered is not only increasing his own understanding of fundamentals but is also making an important contribution to physical progress.

THE MUTUAL INFLUENCE OF ORGANIC COMPOUNDS IN THE ANIMAL BODY

By Professor F. KNOOP

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SEVERAL papers read at the Thirteenth International Physiological Congress in Boston impressed the writer as showing that the ideas of the reciprocal influences between organic substances in the sense of an exchange of energy between each other are not sufficiently known. It seems to me to be important that the simple basis of this kind of consideration should become better appreciated by biologists, and I should like to try to collect into a generally comprehensible form what it was impossible to say in the short time allowed for discussion during the meetings.

Many processes of reduction occur in the animal body for which energy requirements can not, as in plants, be covered by the direct transformation of the rays of the sun. This energy may be supplied by the heat liberated by any process of combustion, as exemplified by fat-production following feeding carbohydrates exclusively. If the organism reduces a ketone to an alcohol, it needs H_2, which is not directly at its disposal. Therefore, another organic compound, undergoing oxidation, gives H_2 not to oxygen, but to the reducible substance and transfers with it part of its heat of combustion. The simplest example of this kind is the disproportion of 2 mol. of aldehyde into 1 mol. of alcohol and 1 mol. of acid (Canizzaro). The heats of combustion in this case are for acetaldehyde:

$$\underset{\text{2 mol. Aldehyde}}{(2 \times 282 =) 564 \text{ Cal.}} = \underset{\text{Alcohol}}{340 \text{ Cal.}} + \underset{\text{Acid}}{209 \text{ Cal.}} + 15 \text{ free Cal.}$$

One molecule of alcohol gains 58 calories from the acid, which contains 75 calories less than the aldehyde. The 15 remaining calories are liberated as heat, thus indicating why the process may take place spontaneously according to general physical laws and can well be accelerated by catalysts. Parnas in Hofmeister's Institute has shown that there are ferments in the animal body which catalyze this reaction with numerous aldehydes.

Wieland has shown in his theory of dehydrogenation that for many oxidative processes the primary and essential reaction is not the entrance of oxygen, but the removal of hydrogen. This H_2 is mostly bound by O_2 when the oxidation takes place in a high O_2 concentration. And since Wieland could demonstrate that $H_2 + O_2$ form H_2O_2, so he proved definitely the value of his idea and, incidentally, the purpose of katalase. Wieland has shown that other substances than oxygen can bind this hydrogen in experiments which agree with those of Thunberg, Schardinger and others. Methylene-blue quinones and analogous substances act here principally as in Canizzaro's reaction —the aldehyde which takes up hydrogen is converted into alcohol. One substance is hydrogenated by another one: the first takes up energy which is provided by the second. The mutual relations of these two substances are believed to be analogous to those existing between many compounds *in vivo* and to typify the energy exchanges of many biological reactions.

The living organism is able to facilitate such oxido-reductions between substances of widely differing kind. It has been known for a long time that aldehydes can be converted into alcohols. The H_2 can only be supplied by other organic bodies. For the hydrogenation of unsaturated linkages and for the transformation even of carbonyl to methylene groups exact chemical proofs can be found in our first paper on β-oxidation. Benzallaevulinic acid is transformed by the dog into phenyl-α-oxybutyric acid, a change requiring both oxidation and hydrogenation of double bonds and carbonyl groups:

$$C_6H_5 \cdot CH = CH \cdot CO \cdot CH_2 \cdot CH_2 \cdot COOH \rightleftarrows$$
$$C_6H_5 \cdot CH_2 \cdot CH_2 \cdot CHOH \cdot COOH [+ C_2 \cdot {}^{*}]$$[1]

Such a transference of hydrogen from one compound to another can also be effected by a third substance. It will always remain as a memorable contribution by Hopkins that he found in glutathione a substance illustrating this function. The SH-group of glutathione is able to furnish this hydrogen or to accept it, and so can reduce or oxidize other substances. Glutathione now is made responsible for all kinds of reductions, even where evidence is lacking. But there is no reason to believe that glutathione is a unique substance of this kind: certainly such processes are facilitated in the body by many compounds of different composition. We have long known that iron in its two stages of oxidation can perform the same function. Organic substances can doubtless act similarly.

Most oxy- and ketonic acids are mutually interconvertible; acetoacetic acid, for example, oxidizes another substance if it robs it of hydrogen and is converted into oxybutyric acid; on the other hand, acetoacetic acid reduces it, if the added hydrogen is transferred to other bodies. The foregoing example can not perhaps be regarded as proved in all details, but other analogous reactions are known. An interesting example is offered by the amino acids, which have thus a new and important function.

Neubauer has shown that the first phase of the decomposition of amino acids in the animal body is an oxidative transformation to a ketonic acid and ammonia. And we have been able to analyze the reaction further after we found the reaction to be reversible.[2] It can for the present be ignored whether an amino-, oxyamino- or an α-β unsaturated acid is first formed—the important fact is that the process of oxidation involving loss of hydrogen can be made retrogressive and the amino acids can be reformed.

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[1] *Hoppe Seyler's Ztschr. für physiolog. Chemie*, 89: 141, 1914.

[2] *Idem*, 67: 489, 1914; 71: 252, 1911.

When this was demonstrated, an old principle was abandoned according to which the chemistry of plants and animals could be fundamentally differentiated by the assumption that the plants can assimilate inorganic nitrogen, but that animals can not do so. This new discovery produced at first only a great deal of discussion concerning its quantitative value, which may be small. But the principle involved in this reaction was ignored. Therefore we have examined more closely the ease with which reduction occurs in this reaction. We have found the surprising result that the reaction takes place very easily. It is well known that a ketonic acid is easily reduced to an *oxy* acid and that the body can do the same thing. But in the presence of only a small amount of ammonia, and the theoretical quantity of hydrogen at room temperature, an α-ketonic acid yields α-amino acids, and little or no oxy acid—which was quite a new result. This synthesis of an amino acid needs less energy than the synthesis of the oxy acid, and this is probably the reason why the latter are usually formed in small amounts. Extended experiments with other ketonic acids and with secondary and tertiary amine bases clearly indicate the general form of the synthesis of the amino acids in nature, which certainly does not follow the same lines that chemists have found in their laboratories. The reaction can be accelerated by catalysts so that 75 per cent. yields of pure amino acids can be obtained at room temperature in a few minutes.[3]

Even if the reaction proceeds only to a limited extent, the system ketonic acid plus ammonia must be able to take up hydrogen from other substances and to oxidize them with regeneration of the original amino acid. The constant combustion of protein in the body provides continually for the new formation of this system, and we have concluded that this reversibility[4] of the first oxidative phase of the degradation of amino acids entitles them to the rôle first of hydrogen-donators and secondly of hydrogen-acceptors. They act after all in principle like Hopkins glutathione.[5] We have further found that this same system can oxidize cystein to cystin with simultaneous formation of the original amino acid.[6] And Bergmann and Enslin[7] have now confirmed the truth of our conclusions. They have demonstrated that the small differences in the redoxpotentials (Michaelis) of individual amino acids suffice to enable one amino acid undergoing the first phase of decomposition to oxidize a second one, with re-formation of the original amino acid. This relationship has been demonstrated between phenylalanin (as phenylpyruvic acid plus ammonia) and aspartic acid. . . .[7]

We must therefore attribute to a great number of organic compounds the capacity to transfer energy from other substances or to furnish it—to oxidize or reduce them. One may be allowed to generalize from these ideas and say that probably every organic substance in the body has in relation to every other one a certain redoxpotential, which will vary according to the conditions, for example, of the pH, of temperature, of O_2 concentration, of the catalysts present, etc. And since the animal can vary these external conditions to a considerable extent, we believe that in the living organism the processes of synthesis and decomposition are regulated by a continuous conflict of all kinds of substances with each other. The extraordinary fineness of the chemical adjustments of the animal body must be referred to this multiplicity of reciprocal actions between all the products of intermediary metabolism. It may be noted that according to this view chemical regulation of the organism's activity may be regarded for the moment to some extent independent of the essential supply of oxygen. We have for long urged that more attention be given to the reciprocal influences of organic substances on one another. In this way we shall acquire a greater knowledge of the chemical abilities of the living cell. I hope that the physical-chemical kind of treatment which Michaelis gives in his new book on redoxpotentials will give us great help. Certainly it emphasizes from a new side the importance of these questions to chemists and physiologists. Reactions such as those referred to are of great general biological interest; for example, the capacity to transform the groups of the main foodstuffs into one another.[8] Thus, the synthesis of fat from protein or sugar, the amino acids of proteins from carbohydrates, etc., gives to animals a wide independence as to the kind of food which is essential.[9] Without these chemical capabilities a much greater amount of animal life would die continually, and especially for the chemist of the anoxybiotics these abilities are of the greatest importance. The animal body can perform all these transformations only because it is enabled to bring in reaction all types of organic substances in a manner which can be here discussed only in general outlines.

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[3] *Idem*, 148: 294, 1925.

[4] The word reversible is used only in the sense of "biologically reversible" and not in the strict physicochemical sense.

[5] *Hoppe Seyler's Ztschr. für physiolog. Chemie*, 148: 302, 1925.

[6] *Idem*, 170: 186, 1927.

[7] *Idem*, 174: 76, 1928.

[8] *Klin. Wochenschrift*, 2: 60, 1923.

[9] *Münch. med. Wochenschrift*, 73: 2151, 1926.

SCIENTIFIC NAMES

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A SMOULDERING impulse to say something more about the wearisome subject of nomenclature suddenly burst into flame the other day when a friend of mine brought to my attention the two following names: *Brachyuropushkydermatogammarus grewinglii mnemonotus* Dybowski and *Microstomaticoichthyoborus bashford-deani* Nicholls and Griscom. The first is a little Amphipod crustacean; the second is a very small fish. If I work with the groups to which they belong, I shall have to handle these names, and I object!

Almost two decades have passed since in these columns[1] I raised the question: Whether there is not a better way of disposing of our nomenclatural trouble than by making it as burdensome as possible, and then making it permanent? Several stalwart defenders of the established order arose to condemn[2] in these columns a simplification that I then proposed, but not one of them ventured a word on the main question. There was no response at all in print, though I did receive a few commendatory letters. I suppose it was because my proposal seemed to threaten the sacred Law of Priority. Hands off it! Give it time. Stability and agreement were just around the corner.

Now there has been time to show what our efforts toward stability alone will do for us. The results are apparent to all. The load of scientific names becomes ever more burdensome and the nomenclatural experts seem to be wholly bent on making that load permanent. And in the name of all who need to use scientific names, and who are not systematic specialists, I object. I ask again whether simplification is not possible.

Biological nomenclature has grown burdensome in part because of increase of knowledge, but in a far larger part because of the artificial premium put upon the giving of names—a premium the like of which is not awarded in any other line of scientific work. Darwin put his finger on one source of our trouble when he wrote:[3]

> . . . I have been led of late to reflect much on the subject of naming, and I have come to a fixed opinion that the plan of the first describer's name being appended for perpetuity to a species has been the greatest curse to Natural History. I feel sure that as long as species-mongers have their vanity tickled by seeing their own names appended to a species, because they miserably described it in two or three lines, we shall have the same *vast* amount of bad work as at present, and which is enough to dishearten any man who is willing to work out any branch with care and time.

But that was only a beginning. The name of the genus also offered a point of attachment for memorials to describers. And it has been availed of fully. Existing rules and practices hold out such promises as this: Coin for a new genus any name that has not been published; couple it with the name of any valid species; give any kind of a description or no description at all; publish it—and you are entitled to write your own name after it, and all who come after you are expected to use it so forever. Was ever a promise of eternal remembrance so cheap!

Little wonder that generic names have multiplied beyond reason! Such devices as prefixes and suffixes enabled the genus-grinders to work faster, and when these began to fail, compounding them followed. Felt and Bishop pointed out that some "have been driven to the making of extremely long names in order to lessen the probability of creating synonyms!"

Nowadays the coining of new generic names has become so common that it has lost some of its charm, and the true experts in taxonomy are devoting themselves assiduously to the coining of new family and subfamily names, for, under the newer practices these, also, may carry forever the names of their inventors. The experts now go gunning for bigger game. And, at the present rate, we shall soon have in a large part of the system a subfamily for every genus. When these names represent new taxonomic discoveries they are perhaps excusable, but often they are merely *new names* applied to groups already set apart by previous workers.[4]

Subfamily names need not detain us here. They are the concern of the systematic specialist. Let those who want them have them. It is the scientific name of the species that we all use, the name by which it is known everywhere and in all languages alike. This name is in two parts, genus and species—like surname and given name of a person; this since the day of Linnaeus. Strange things have been happening to his simple helpful system of binomials. His names were pronounceable and fit. Forty years ago when I argued with some of my friends in favor of *appropriate* names, I was silenced with the dictum: "A name is a name and not a definition." His names were brief; but now in all the better-known groups, trinomials are the rule and quadrinominals are becoming common. I myself trudge along lonesomely at the tail of the procession. For me, if a form is distinct enough to bear a name at all, that name shall be a binomial. And I meet the queries of my taxonomic friends with another *dictum*: "A name is a name and not a treatise on relationships."[5]

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[1] SCIENCE, 32: 296, 1910.

[2] T. D. A. Cockerell, SCIENCE, 32: 795, 1910; D. S. Jordan, SCIENCE, 33: 370, 1911; *et al.*

[3] Quoted in "Life and Letters of Charles Darwin," by F. Darwin, p. 334.

[4] If I be taken to task again, as I was recently by my friend Dr. Jordan (SCIENCE, 66: 14, 1927) for disrespect to taxonomists, "a signally unselfish and conscientious group," my complete answer is: Am not I myself, in a small way, a describer of new genera and species?

Some editors are now so well disciplined in correct usage that they require the addition of the name of first describer throughout, in all the manuscripts that they accept for publication. When there are joint authors and tri- and quadrinomials this makes a fine string of names.[6] Some add to original describer's the name of the man who puts the thing in another genus than that in which it first reposed. I do not do this, and I justify my slowness with another dictum of my own: *A name is a name and not a memorial inscription.*

So, I agree that a name is a name. But, though a name is only a name it may yet be a helpful thing or a very positive hindrance. The two names quoted in my first paragraph are examples of the latter. They are far worse than anything pre-Linnaean.[7]

My point is not that names are so numerous—they must be as numerous as the species—but that they are so inanely foolish as to hinder the progress of biological science. How many species names there may be does not concern the general worker. He needs as many of them as there are kinds of plants or animals before him, and the others do not bother him. But the number of generic names does concern him; for if he has to learn a new genus name for almost every species, that name is no aid at all, but only an added burden on his memory. Furthermore, it is obscuring, not clarifying. The original purpose of the generic name was to tie the species up in convenient bundles so that the mind might the more easily deal with them. The general worker needs only enough generic names to cover readily distinguishable groups. Modern infinitesimally split genera, based on differences that only a specialist can see, tend to obscure affinities. The taxonomic specialist is apt to think of large genera as "unwieldy"; but the real unwieldiness lies in the excessive array of handles with which he supplies his little bits of intellectual luggage.[8]

In 1910 I tried to start a discussion of the problem of simplifying our nomenclature. I suggested numbering species; but numbering does not accord with our traditional habit of naming things. That was not a good suggestion. Let it pass. I now try again.

I suggest a return to simple binomials with fewer genera and a standard name list for the use of all who deal with plants and animals otherwise than as taxonomic specialists. Such a list would present the little crustacean mentioned in my first paragraph not as *Brachyuropushkydermatogammarus grewinglii mnemonotus* Dybowski, but as *Gammarus mnemonotus* and nothing more.

Let the existing system stand for the systematists. Let it grow and flourish. Let the splitters have their revel. The *mihi* itch is such a delightful disease, I would by no means deprive my worthy systematic colleagues of the pleasure they find in scratching. But let us have simpler names for common use.

In these pages I am not proposing a plan, but an inquiry to develop a plan. It is only by agreement that the present system came into existence. To say that biologists might not yet be able to agree upon something a little less distressing and less a hindrance to biological science would seem to me very like a confession of professional idiocy.

There are, however, four provisions I should hope for in the new undertaking:

1. A preliminary report to competent psychologists as to desirable and necessary name-limitation.
2. Cooperation between botanists and zoologists.[9]
3. Members-at-large in the name-choosing body, to secure a measure of uniformity.
4. Members serving only for the groups in which they are taxonomic specialists, to bring to bear a working knowledge of the group and of its literature and tradition.
5. Some better method of obtaining the opinion

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[5] Whether Marcus Smith is first or second cousin to John Smith his name need not explain.

[6] Here are the up-to-date names of five species of bumblebees: *Cullumanobombus silantjeivi semenoir-tianshanskyi* Shorikov; *Pratobombus lapponicus kamtshaticus occultodistinctus* Shorikov; *Agrobombus solstitialis subbaicalensis insipidioides* Vogt; *Agrobombus agrorum parcuorum subdrenowskianus* Vogt; *Pratobombombus jonellus atrocorbiculosus sparre-schneideri* Vogt.

[7] If any one thinks that such monstrosities in names are isolated cases let him read the four pages of generic names derived from personal names in Palmer's "Index Generum Mammalium" (*N. Amer. Fauna*, no. 23, pp. 48–51, 1904): Asmithwoodwardia, Ernestohaeckelia, Ricardolydekkeria, etc.

[8] The true aim of taxonomy was well stated by J. Chester Bradley in SCIENCE, 66: 103, 1927.

[9] Without this, we who are ecologists may have to go on forever writing the names of plants one way and the names of animals another. Must we capitalize and parenthesize and eulogize first describers and last shifters in two ways, merely because the plant and animal taxonomists have neglected to get together? We do not like it. It is not rational.

of zoologists than the *viva-voce* vote of the crowded sessions of an international congress.

I speak for the conscientious teachers who seek to give their pupils some contact with biological literature. Confusion of names, absurdity of names, apalling length of names waste their time and dull the interest of their pupils. In some quarters it seems to be expected of the teachers that they shall meekly and apologetically explain to their pupils that all this foolishness is due to the vastness of plant and animal creation. But it is not so. The fact that there are more than a million species of animals in the world does not of itself necessitate that the bird in my hand shall bear a harder name.

I am well aware that it will be no easy task to find a way out of the existing confusion. Good judgment, expert knowledge, human sympathy, hard labor and long patience will all be required. When these have been applied we may hope for something better. It surely is not well to have scientific effort so organized as to reward mistakes and to preclude the elimination of errors.

SCIENTIFIC EVENTS

ENGINEERS IN AMERICAN LIFE

MEN of science are assuming a dominant position in American life, Lawrence W. Wallace, of Washington, executive secretary of the American Engineering Council, said in an address at the recent annual meeting of the American Society of Mechanical Engineers in New York. By supplementing with broad humanistic and scholarly interests the technical genius responsible for the "Machine Age," they are becoming a controlling force in culture and in politics no less than in commerce and industry, in finance, in education, and in national defense, Mr. Wallace asserted, making public the results of a survey of "Engineers in American Life" which he conducted in association with Joshua Eyre Hannum, research engineer of New York.

Of the 28,805 "notable living men and women of the United States" named in "Who's Who in America" (1928–1929), 2,858 were engineers and architects. They received 1,417 academic degrees in branches of learning other than science, as well as 2,497 scientific degrees. They are members of 1,138 associations, conferences, boards and commissions, half of which are non-technical.

They hold 4,785 official positions in 3,928 organizations, of which number 2,993 are industrial and commercial companies. They occupy the position of president in 1,128 industrial and commercial organizations, 72 engineering firms, 68 banks and trust companies and 23 colleges and universities.

Among these 2,858 engineers and architects there are, or have been, 10 governors, 13 members of Congress, 2 members of the Cabinet, and the president of the United States. Five hundred and eighty-eight of these men hold 905 memberships in Phi Beta Kappa, Phi Kappa Phi, Sigma Xi and Tau Beta Pi, the four honorary fraternities in which membership connotes outstanding achievement in various fields.

The men studied hold membership in 1,138 associations, commissions, conferences, and the like, half of which are non-technical. The activities of these organizations touch practically every interest of mankind, and they are not restricted geographically, but are located in many parts of the world.

Nearly 40 per cent. of the group are officers of industrial and commercial companies. Of the entire group, 37.1 per cent. are available for consultation, 34.8 per cent. have made contributions to scientific and technical literature and 6.9 per cent. have been editors of technical papers.

In the fields of public service scientific men have made important inroads. Over one half of the men under consideration have served or are serving municipal, state or federal governments. City governments have been served by 208 of these men. Among them have been 28 city engineers, 18 mayors, 6 city managers, 3 chiefs of police and 2 superintendents of city schools.

State governments have engaged the efforts of 269 of the group, 59 of whom are now in state work. There have been 10 governors, 5 legislators and a state district attorney among them. The present governors of Delaware, Utah, Wyoming, New Jersey, Alaska and Alabama are engineers. The governors of North Carolina and Indiana hold engineering degrees.

In our federal government, the president of the United States, the secretary of the interior, the secretary of commerce and the director of the budget are among the men of science holding important positions. To name the various branches of the federal government in which engineers hold responsible offices would be to catalogue the activities of the government. Suffice it to say that no other group is more influential in shaping the destiny of the nation.

DENTAL COUNCIL ON MATERIA MEDICA AND THERAPEUTICS

THE American Dental Association announces the formation of a proposed council to deal with dental materia medica and therapeutics.

The functions of the council will be to aid the dental profession to further rationalize its materia medica and therapeutics by fostering a spirit of chemical mindedness on the part of the dental profession, and to protect the dental profession and public against fraud, undesirable secrecy and objectionable advertising in connection with proprietary dental remedies. For the immediate future, the council will confine its attention to the examination of drugs and dental proprietaries for inclusion in an "accepted list." It is planned, however, that the scope of the council will eventually be enlarged to consider ceramic and metallurgical products and physical therapeutic apparatus in the dental field. The endeavors of the council will also be directed toward an improvement in pharmacological and biochemical instruction in dental colleges.

Invitations to serve on the council have been accepted by the following:

Paul J. Hanzlik, professor and head of the department of pharmacology, School of Medicine, Stanford University.

Percy R. Howe, Thomas Alexander Forsyth professor of dental science, Harvard University, and director, Forsyth Dental Infirmary for Children, Boston, Massachusetts.

Milan A. Logan, instructor, department of biological chemistry, Harvard Medical School.

Arno B. Luckhardt, professor of physiology, University of Chicago.

John A. Marshall, associate professor of dental pathology and biochemistry, College of Dentistry, University of California.

Victor C. Myers, professor of biochemistry, Western Reserve University.

John F. Norton, chief of laboratories, department of health, Detroit, Michigan, formerly professor of bacteriology and hygiene, University of Chicago.

U. G. Rickert, professor of physiological chemistry, hygiene and therapeutics, School of Dentistry, University of Michigan.

Harold S. Smith, practicing dentist, Chicago, Illinois.

As *Ex-officio* members:

C. N. Johnson, editor of the *Journal* of the American Dental Association.

Harry B. Pinney, secretary of the American Dental Association.

Samuel M. Gordon, American Dental Association chemist and former National Research Council Fellow in the Biological Sciences, has been appointed secretary of the council.

The first meeting of the council was held in Chicago on January 3 and 4, 1930. Examinations of purely dental nostrums will be dealt with by the Bureau of Chemistry of the American Dental Association as heretofore.

GOLD MEDALS OF THE MASSACHUSETTS HORTICULTURAL SOCIETY

TRUSTEES of the Massachusetts Horticultural Society have made their final survey for the centennial year and awarded twenty centennial gold medals, eighteen centennial silver medals, six large gold medals and made two special awards. The gold medals, as announced in the *Boston Transcript*, are as follows:

Albert C. Burrage, president of the Massachusetts Horticultural Society, for eminent service in horticulture.

T. A. Havemeyer, president of the Horticultural Society of New York, for his many years of distinguished service to horticulture.

F. R. Newbold, secretary of the Horticultural Society of New York, for his many years of distinguished service to horticulture.

John C. Wister, secretary of the Pennsylvania Horticultural Society, for his many years of distinguished service to horticulture, especially through his writings and lectures.

Worcester County Horticultural Society, organized in 1840 and ever since that date a potent factor in the advancement of horticulture in Massachusetts.

Dr. Henry P. Walcott, as a fitting tribute to a former president of the Massachusetts Horticultural Society.

Nathaniel T. Kidder, as a fitting tribute to a former president of the Massachusetts Horticultural Society.

General Francis H. Appleton, as a fitting tribute to a former president of the Massachusetts Horticultural Society.

William C. Endicott, as a fitting tribute to a former president of the Massachusetts Horticultural Society.

Professor Oakes Ames, for his service to orchidology. The botany of the orchid has been Professor Ames's life study, and no man stands higher in this field.

Professor Ernest H. Wilson, for his inspirational books. Besides being the greatest of living plant hunters, Mr. Wilson has a rare capacity for transferring his knowledge to paper.

Olmsted Brothers, Brookline, for their work in raising the standard of landscape architecture and especially in the development of public parks. There is hardly a corner of the country where their influence has not been felt.

Harlan P. Kelsey, East Boxford, for his work in behalf of better horticultural nomenclature. He was New England's representative on the committee responsible for standardized plant names.

Alexander Montgomery, Hadley, for his work in originating new roses. The fame which Hadley, Crusader, Templar and Talisman have brought to the man who originated them is shared with the state in which he lives.

Mrs. Susan D. McKelvey, for her notable monograph on the lilac, the most important work of the kind ever undertaken in this country.

Mrs. S. V. R. Crosby, for her work in the conservation of wild flowers. Her high purpose and practical methods as president of the New England Wild Flower Preservation Society have won the deepest respect and appreciation.

Miss Marian Roby Case, for her work with boys at Hillcrest Gardens. For twenty years Miss Case has devoted her time and fortune to an experiment in education and horticulture which has proved unique and has attracted wide attention.

Kidder, Peabody & Company, Boston, for demonstrating the fact that a beauty spot can be made in the heart of a great city.

William Filene's Sons Company, Boston, for the example set by them in their consistent use of window boxes on business houses.

Professor B. L. Robinson, for his eminent service to botany. As head of the Gray Herbarium, Professor Robinson has carried on much important work with distinguished success.

PRESENTATION TO PROFESSOR NOVY

FRIENDS, colleagues and students of Dr. Frederick G. Novy, since 1902 professor of bacteriology at the University of Michigan, united on the occasion of his sixty-fifth birthday in the presentation of a full-sized oil portrait, painted by J. E. Weiss, and a volume containing two hundred letters of greeting from scientific men throughout the world.

Dr. Aldred Scott Warthin, head of the department of pathology, in presenting the portrait, said:

> We are assembled here to render richly deserved honor to a distinguished colleague, who for 43 years has been a worthy and faithful servant of the university. Not only as an original and forceful teacher, but much more as a scientific investigator, he has added luster to the fame of the university and medical school. More than any other single member of its faculties he has contributed to their international reputation. His name is known in all lands where modern medical science has a foothold, and it will be perpetuated to coming generations through the many imprints it has made upon the terminology of bacteriological science. The fame of the university can rise no higher than that of the individual members of its faculties. It is a collective fame, increasing from generation to generation as successive men of note follow one another in its professorships. It would seem fitting that an effort be made to perpetuate the memory of those who, in their day, gave of their best, in contributing to the university's intellectual development. It is with this object in view, that the colleagues and old students present this portrait to the university, of the man they delight to honor, Professor Frederick G. Novy.

In reply, as he accepted the painting, Dr. Ruthven said:

> We are met to-day to honor a man famed as a teacher, who has to an enviable extent contributed to the progress of science and to the advancement of scholarship at the University of Michigan, a man, moreover, who as our colleague has by his example and personality endeared himself to us, inspired us in our labors, and made us proud to have known him in his work. In honoring him we are not only giving him his due but we are also indicating our belief that the university stands for creative scholarship as well as for sound teaching. We will place this emblem with the prayer that it may inspire generations of students to emulate the subject it portrays.

THE GEORGE HERBERT JONES CHEMICAL LABORATORY OF THE UNIVERSITY OF CHICAGO

A LARGE group of distinguished chemists attended the dedication ceremonies, which extended over December 16 and 17. Mr. Jones, in presenting the laboratory, said: "The department of chemistry has done exceedingly well in the past; I hope that this new laboratory will assist it to accomplish much in research in the future, and especially will prove of value to industry."

President Robert Maynard Hutchins, in accepting the building for the university, said: "Through the generosity of Mr. Jones, a department with a brilliant history may look forward to a yet more brilliant future. Of the two hundred and sixty men and women who received the Ph.D. degree on recommendation of the department, twenty-four are heads of departments in colleges and universities; fifty-seven hold university professorships; fifty-eight occupy college chairs; twenty-two are active in research institutions, and eighty-five are engaged in industrial research. Obviously, what goes on in the department affects the progress of scientific investigation throughout the country, and has the most direct and important bearing on our educational system."

A plaster cast of the bronze bust of the donor, which when completed is to be placed in the lobby of the laboratory, was presented to the university by Mrs. Walter J. Jarratt, daughter of Mr. Jones, and accepted by Mr. David Evans, president of the Chicago Steel Foundries. Dr. F. W. Upson, a Ph.D. of the department, presented on behalf of alumni and friends a bronze bust of the late John U. Nef, and Mrs. Sara Bowles Smith presented a bust of the late Alexander Smith, both at one time members of the department.

Associate Professor John W. E. Glattfeld spoke on "Nef, the Man and Teacher," and Dr. Herman A. Spoehr, of the Carnegie Institution, Stanford University, on "Nef, the Investigator." W. D. Richardson, chief chemist of Swift and Company, gave an address on "Smith, the Man and Teacher," and R. H. McKee, professor of chemical engineering in Columbia University, spoke on "Smith, the Investigator."

A bust of Professor Stieglitz was presented by Dr. B. B. Freud, on behalf of alumni and friends, and accepted by Professor Hermann I. Schlesinger.

Participating in a program on the general subject of "Some Present and Future Problems in Chemistry" were Dr. G. N. Lewis, head of the department of chemistry in the University of California, whose topic was "Physical Chemistry"; Dr. C. H. MacDowell, president of the Armour Fertilizer Works, "Chemistry Applied to Industry"; Dr. Edward R. Weidlein, director of the Mellon Institute of Industrial Research in Pittsburgh; Dr. Charles A. Kraus, head of the department of chemistry in Brown University, who discussed "Inorganic Chemistry"; Dr. Moses Gomberg, head of the department of chemistry in the University of Michigan, and Associate Professor M. S. Kharasch, whose topic was "Organic Chemistry." Dr. Carl Voegtlin, of the United States Public Health Service, and Dr. A. P. Locke, Seymour Coman fellow in chemistry applied to medicine, spoke on "Chemistry and Medicine."

SCIENTIFIC NOTES AND NEWS

THE one thousand dollar prize offered annually by the American Association for the Advancement of Science for "a noteworthy contribution to science" presented at the meeting was awarded at Des Moines to Professor Arthur J. Dempster, of the University of Chicago. Professor Arthur H. Compton, with whom Professor Dempster is associated at Chicago, is reported to have said: "The most important contribution of twentieth-century physics is that the physical world can be reduced to three kinds of particles—protons, electrons and photons, and that each of these particles has also the characteristics of waves. The last stage is the proof that the protons, the positively charged parts of matter, have wave characteristics. It is this completion of the great work of twentieth-century physics which has been accomplished by Professor Dempster."

THE first gold medal awarded by the New York Academy of Medicine has been conferred on Dr. Carl Koller. The medal was presented by Dr. John A. Hartwell, president of the academy, the citation read by Dr. Linsly R. Williams being as follows: "Dr. Koller, distinguished ophthalmologist, able in the field of biology, painstaking in research, the discoverer of the anesthetic properties of cocaine, the inaugurator of the era of local anesthesia, conferring on humanity an enormous relief from suffering, a fellow of this academy since 1898, in recognition of his services is awarded this first academy medal."

THE Perkin medal is to be presented on January 10 to Dr. Herbert H. Dow, president of the Dow Chemical Company, of Midland, Michigan. The presentation is made because of his developments of improvements in the production of chlorine, bromine, magnesium and numerous other chemical materials. The presentation will be at a joint meeting of the Society of Chemical Industry, American Chemical Society, the Société de Chimie Industrielle and the American Electrochemical Society. An informal dinner at 7:00 P. M. will precede the meeting. The following program will be presented in Rumford Hall of the Chemists' Club at 8:15 P. M.: "Early Days of the Medalist," James T. Pardee; "Accomplishments of the Medalist," E. O. Barstow; presentation of Perkin medal, Marston T. Bogert, and acceptance speech, Herbert H. Dow. Dr. Dow will speak on the "Economic Trend in the Chemical Industry."

THE A. Cressy Morrison Prizes of the New York Academy of Sciences for 1929 have been awarded as follows: For the most acceptable paper in the field of experimental biology, embodying the results of original research not previously published, to Michael Heidelberger and Forrest E. Kendall, for their joint paper entitled "A Physico-chemical Interpretation of an Immune Reaction: A Quantitative Study of the Precipitin Reaction between Type III, Pneumococcus Polysaccharide and Purified Homologous Antibody." For the most acceptable paper in a field of science covered by the academy or an affiliated society, but not included in the above, which paper embodies the results of original research not previously published, to Horace W. Stunkard, for his paper entitled "The Life History of *Chryptocotyle lingua* (Creplin) with Notes on the Physiology of the Metacercariæ."

DR. THEOBALD SMITH, of the department of animal pathology of the Rockefeller Institute for Medical Research at Princeton, has agreed to act as consultant in bacteriology to the division of laboratories and research of the New York State Department of Health at Albany. Dr. James Ewing, professor of pathology at Cornell University Medical College in New York City, has accepted the appointment of consulting pathologist to the laboratories.

DR. HERBERT V. NEAL, professor of zoology and dean of the graduate school of Tufts College, was elected president of the American Society of Zoologists at the recent Des Moines meeting. E. E. Just, professor of zoology in Howard University, Washington, D. C., was elected vice-president.

AT the annual meeting of the Board of Trustees of the American School of Prehistoric Research held at Vassar College, December 28, 1929, Professor George Grant MacCurdy, of Yale University, was reelected director of the school for a term of two years. With the exception of 1922 and 1923, Dr. MacCurdy has been director of the school since it was founded nine years ago.

At the annual meeting of the Royal College of Physicians, London, on December 5, Sir Norman Walker was elected president and Dr. Robert A. Fleming vice-president.

Professor Thomas J. Talbert, of the department of horticulture in the college of agriculture of the University of Missouri, has been elected governor of the Missouri-Kansas-Arkansas district of Kiwanis Clubs for the year 1930.

Dr. Harvey W. Wiley has resigned as director of the *Good Housekeeping* Bureau of Foods, Sanitation and Health which was established by and for him in 1912. He becomes director emeritus.

The *Bulletin* of the American Mathematical Society reports that on account of the death of Dr. J. W. L. Glaisher, editor of the *Quarterly Journal of Mathematics* and the *Messenger of Mathematics*, the former journal will be discontinued, with the completion of its fiftieth volume. Professor G. H. Hardy has consented to edit the current volume (volume 58) of the *Messenger of Mathematics*, and it is hoped that this journal can be continued.

Dr. Henry Knute Svenson has taken up the work of curator of plants at the Brooklyn Botanic Garden. Previous to accepting this appointment, Dr. Svenson was connected with the editorial office of *Biological Abstracts*.

E. P. Henderson, of the U. S. Geological Survey, has been appointed assistant curator of applied geology in the U. S. National Museum.

Nelson S. Perkins has been appointed to succeed Dudley F. Holtman as construction engineer of the National Committee on Wood Utilization.

Dr. Albert F. Zahm, who was recently appointed to the new Guggenheim chair of aeronautics at the Library of Congress, has taken up his new work. He has been director of the aerodynamic laboratory of the Navy Department since 1916.

Dr. Sanford R. Gifford, of Omaha, who has been appointed head of the department of ophthalmology at the Northwestern University School of Medicine, Chicago, took up his work on January 1.

Dr. L. A. Calkins, formerly head of the department of obstetrics and gynecology at the University of Virginia, has been appointed head of the department of obstetrics and gynecology at the University of Kansas School of Medicine.

Dr. Walter B. Cannon, George Higginson professor of physiology at the Harvard Medical School, has sailed for France to serve as Harvard exchange professor at the Sorbonne and at the Ecole de Médecine in Paris. He will lecture also at provincial universities in France and in the Belgian universities during the second half year.

Dr. Frederick L. Hoffman, consulting statistician, Wellesley Hills, Massachusetts, will participate in the Latin-American Medical Congress, reading an address on "The Value of Vital Statistics in Latin-American Countries." Dr. Hoffman will go by aeroplane from Birmingham to Mexico City, and will also make a flight to Yucatan. He expects to cover about three thousand miles or more by plane before he returns.

The *Journal* of the Washington Academy of Sciences reports that Professor C. H. Ostenfeld, director of the Botanical Garden and Museum, Copenhagen, Denmark, recently spent several days in Washington, giving particular attention to Alaskan plants in the National Herbarium, especially those of Arctic Alaska. His studies were undertaken in connection with the preparation of a flora of northern Canada, a project upon which he is jointly engaged with Dr. M. O. Malte, chief botanist of the Canadian National Herbarium, Ottawa.

Llewellyn N. Edwards sailed from New York on December 20 for the British Isles, where he will study methods of design and construction of highways and bridges and will also devote some time to engineering research and investigation work in progress there. He plans to make a study of early bridge structures having historical value in the engineering profession.

Dr. Paul Bartsch, of the U. S. National Museum, has returned from a trip to the West Indies, made under the auspices of the Walter Rathbone Bacon traveling scholarship. He visited most of the islands between Porto Rico and Trinidad, except Antigua and Barbuda, which had been thoroughly explored by Mr. J. B. Henderson, and Barbados. After leaving Trinidad, his expedition sailed along the coast of South America, visiting the Leeward Islands, Margarita, Orchilla, El Roque, Bonaire, Curaçao and Aruba.

Dr. Alan M. Chesney, associate professor of medicine of the Johns Hopkins School of Medicine, will deliver the fourth Harvey Society Lecture at the New York Academy of Medicine, on Thursday evening, January 16, 1930. His subject will be "Acquired Immunity in Syphilis."

Dr. Henry A. Christian, Hersey professor of the theory and practice of physic at the Harvard University Medical School, will deliver the annual lecture of the Scripps Metabolic Clinic at La Jolla on January 25 on "Chronic Non-valvular Heart Disease: Its Causes, Diagnosis and Management."

THE address of the retiring president of the Philosophical Society of Washington was given on January 4 by Dr. Leason H. Adams on "The Significance of Pressure in Geophysical Investigations."

THE biennial Huxley lecture was given by Sir William Bragg in the Charing Cross Hospital Medical School on November 28 on "The Crystal Structure of Organic Substances in Its Relation to Medicine."

BOTANISTS, plant physiologists and phytopathologists planning to visit France at the time of the botanical meetings to be held in Cambridge next year are asked to communicate as soon as possible with Dr. Jean Dufrénoy, Station de Pathologie Végétale, Etoile de Choisy, Versailles, S. O., France, in order that an organized trip through France may be arranged.

AN Associated Press dispatch reports that seventeen Russian agricultural engineers arrived from Moscow on December 29 on the *Nieuw Amsterdam* to study the manufacture of farming implements in the United States. They are reported to have said that the Soviet government is planning to construct the world's largest factory for the manufacture of agricultural machinery and implements at Nijni-Novgorod.

THE twentieth annual exhibition of electrical, optical and other physical apparatus was held by the Physical Society and the Optical Society, London, on January 7, 8 and 9, at the Imperial College of Science and Technology, South Kensington. As on previous occasions, there was a trade section and a research and experimental section.

THE yacht *Corsair* has been formally transferred to the service of the United States by Mr. J. Pierpont Morgan. The yacht was renamed the *Oceanographer* before the transfer was made and will be used in the recharting of the Atlantic and Gulf seaboard by the Coast and Geodetic Survey. It is stipulated that the vessel shall not be disposed of by the government until it is scrapped. It will be placed under the command of Captain F. L. Peacock, of the Coast and Geodetic Survey.

THE Secretary of the Interior announced on December 2 that the advisory committee on education by radio had received grants from the Carnegie Corporation of New York, the J. C. Penney Foundation and the Payne Fund, amounting to $16,500, and that the Payne Fund had lent the services of an expert for several weeks. With these resources it is expected that the committee will continue to conduct investigations into the extent to which radio has been used in school work and by colleges for broadcasting programs of an educational nature. The committee intends to make some recommendations for scientific research designed to ascertain the effectiveness of radio as an educational tool.

EMILE PICARD, general secretary of the Academy of Sciences in Paris, has received from an American, who prefers to remain anonymous, a check for 300,000 francs, for the "Amis des sciences," a society organized for the aid of unfortunate scientific men and their families.

THE Field Museum of Natural History has begun publication of a monthly bulletin, *Field Museum News*, which is to be circulated among the institution's members, now numbering nearly 6,000. Announcements, reports and records of all museum activities will be published in the periodical, including notes on additions and improvements in the exhibition halls, and accounts of the work conducted in the museum's scientific research laboratories, and by its many expeditions operating in widely scattered and remote parts of the world. Dr. Stephen C. Simms, director of the museum, is the editor. Contributing editors include Dr. Berthold Laufer, curator of anthropology; Dr. B. E. Dahlgren, acting curator of botany; Dr. O. C. Farrington, curator of geology, and Dr. Wilfred H. Osgood, curator of zoology. H. B. Harte, head of the museum's division of public relations, is managing editor. The paper is printed by Field Museum Press, the museum's own plant, which also prints the scientific books and pamphlets published by the museum. A feature of the January issue is the first installment of a history of the museum since it was founded by Marshall Field in 1893, written by Dr. Farrington, who is dean of the scientific staff, having been head of the department of geology since the museum's earliest days.

THE mining interests of central Pennsylvania have organized an advisory board to cooperate with the school of mineral industries of the Pennsylvania State College. At a recent meeting in Johnstown members of the board studied the curriculum and research projects with the object of making any suggestions which might bring the college service closer to the industry. A board representing the western mining interests was organized in December and one from the anthracite fields will be formed in the spring.

Industrial and Engineering Chemistry reports that efforts of American chemists to save from destruction by mold the only official records of the construction period of the Panama Canal, a series of five mural paintings in the Administration Building at Balboa, have been successful. W. B. Van Ingen, instructor in Cooper Union, supervised the treatment of the pictures. When the presence of mold, the gangrene of paintings, became apparent on the pictures last year, Mr. Van Ingen, who painted the series at the request of George R. Goethals, builder of the canal, was commissioned by Harry Burgess, governor of the Canal Zone, to undertake the restoration of his paintings. The treatment finally used was devised by Albert B. Newman, director of the department of chemical engineering at Cooper Union, with the cooperation of Charles Thom, chief mycologist of the Bureau of Chemistry and Soils of the Department of Agriculture; Alexander Scott, of the British Museum, and other mold experts. Mr. Van Ingen said that the thin film of paraffin covering his pictures would remain unchanged indefinitely, and would prove an absolute protection against the effects of exposure to the tropical climate as long as it existed. The use of paraffin was suggested by the experience of New York City engineers, who made an extensive examination of the Obelisk in Central Park to determine how it could be protected from the city climate. Among the mold experts who assisted Mr. Van Ingen and Professor Newman, in addition to Drs. Thom and Scott, were: Lewis T. Bates, chief of the laboratories of the Health Department of Panama; Bernard O. Dodge, plant pathologist of the New York Botanical Garden, where important research in this field is in progress; Charles F. McCoombs, of the New York Public Library; T. R. Beaufort, professional picture restorer; Leslie Ewart Morris, of the British Cotton Research Association; George Smith, of England, and Hugh L. Robinson, editor of the *Journal of the Textile Institute of Manchester*.

PLANS are now well advanced, under the direction of Sir Richard Allison, chief architect to the Office of Works, London, for the construction of the building which is to house the Museum of Practical Geology. The museum is at present in Jermyn Street, and the new site is in South Kensington, adjoining the Science Museum in Exhibition Road, just beyond the northeast corner of the Natural History Museum, and the proposal is to connect the new structure by a bridge with the Science Museum, from which it will be only a few yards distant. Although the plans for the new building are not yet complete, they are far enough advanced for a beginning to be made very shortly in constructing the foundations. The estimated cost of the new building is £220,000. The general scheme is that it shall be on four floors, with a top-lighted roof and central well. The problem of finance is simplified by the fact that the site in Jermyn Street, which belongs to the Crown, is of great value. The museum was founded in 1852. Its library is essentially a library of the geological surveys and maps of the world, together with the economic geology of Britain, the British Dominions and the world generally. Huxley and Tyndall were among those who at one time lectured in the museum. In 1900, during reconstruction, the lecture hall was thrown into the museum library. It is hoped to resume the lectures in the new building or in the lecture theaters of adjacent museums in South Kensington.

The British Medical Journal reports that the act to incorporate a Royal College of Physicians and Surgeons of Canada received last June the royal assent, and in accordance therewith an inaugural meeting, convened by the general secretary of the Canadian Medical Association, was held at Ottawa on November 20. This meeting was attended by sixty of the leaders of the medical profession in Canada, designated charter fellows, and it marked the culmination of a movement which began in 1920. The act provides that the council may organize the college into medical and surgical divisions, those admitted into them being designated fellows of the Royal College of Physicians of Canada or fellows of the Royal College of Surgeons of Canada (or their equivalents in the French language). At the inaugural meeting, Toronto was chosen as the headquarters of the college; Professor Jonathan C. Meakins, of McGill University, Montreal, was elected president; Professor Duncan Graham, of Toronto, vice-president in charge of the medical division, and Dr. F. N. G. Starr, also of Toronto, vice-president in charge of the surgical division. Dr. T. C. Routley, general secretary of the Canadian Medical Association, was elected registrar-secretary.

DISCUSSION

SOME LIMITATIONS OF THE EXPERIMENTAL METHOD IN BIOLOGY

AT the present time much is being written as to the value of the experimental method of attack in biological problems. There can be little doubt of the great utility of the experimental method of approach, but in itself this method may lead to extremely fallacious conclusions. A notable example, apparently, of this deplorable result is presented by current investigations on the experimental production of new species. Obviously, in pursuing the study of experimental evolution we must keep our eye closely focused on the conditions in nature because it is under the conditions prevailing in nature that new species appear from time to time. The normal course of events in the case of the coming into existence of members of a species has been contemptuously designated by one of our prominent experimental biologists as "the passing show." If we were to continue the figure of the show, we would on the same basis naturally characterize a great deal of the experimental work on species, at the present time, as a "side show."

One must, indeed, apparently regard the prevailing use of radiations on the chromosomes of plants and animals in this light. It has been shown beyond any question that it is possible to modify the chromosomal structure in both plants and animals by means of radiations of various sorts. It has not been shown that such treatment can produce permanent and normal species. Further, it is far from clear that radium emanations or X-rays can ever have played any important rôle in affecting permanently the chromosomal organization of the germ-cells in either plants or animals. Consequently, from the practical standpoint of the experimental evolutionist, actinic experimentation is not likely to lead to any result of lasting importance. In making this statement it will naturally be admitted that such experimental work is of great interest and, from the standpoint of the pathologist and the surgeon, may be ultimately of great importance. From the standpoint of the investigator of the origin of species, it is ruled out of court at the outset by reason of the non-viability of its product.

We are becoming more and more aware, particularly on the plant side, that species cross in nature to a hitherto unexpected extent, and that when two species are crossed almost anything may happen, from the production of an almost infinitely variable progeny to the origin at once of a new, fixed species. It is apparent as a result of correlated cytological and experimental work that many of our large genera of plants are composed of species which are more or less contaminated by hybridism. This, for example, is notably the case with the roses of Europe, the hawthorns of America and the blackberries of both continents. Nor is the northern hemisphere alone in this hybrid multiplication of species. The hundreds of species of Acacias, or "wattles," in Australia afford a similar case of multiplication and variability of species due to hybridization. The same is true of the Australasian genus Eucalyptus of which there are so many and so variable species that their study has given rise to specialists in Eucalyptology.

In his "Origin of Species," Darwin, with that sanity of judgment which makes him so outstanding a figure in the biological sciences, pointed out that the most important element in the origin of species was the innate tendency of species to vary. In his time no explanation was forthcoming of this tendency to variability, but Darwin, with characteristic keenness of insight, pointed out that the greatest variability was found in the species of large genera. This statement, in view of the investigations of the last two decades, was nothing less than prophetic. As a consequence of our present correlation of experimental and morphological study of natural and experimental hybrids, we have come to realize that many species of plants in nature are the result of previous hybridization. There can be little doubt that the same condition prevails on the zoological side and under the same conditions. It is becoming, for example, apparent that many organisms representing large genera of animals are extremely variable and in many instances present the cytological characteristics of hybrids.

One of the most fruitful fields of investigation in connection with Darwin's great work, "Origin of Species," was the comparison between domesticated animals and cultivated plants and plants and animals in nature. In our time, hybridism plays an enormous rôle among the plants of our gardens. Many of the most desirable of these are known to be of hybrid origin. Further, many of our useful plants whose origin is buried in antiquity, by their variability and cytological peculiarities, seem clearly to represent old-time hybrids. This is notably the case, for example, in such common plants as the potato, Indian corn, etc.

Not only are many cultivated plants of known or suspected hybrid origin, but more and more examples of hybridism are being recognized in nature. For example, Trelease has called attention to the fact that there are practically as many hybrids of our American oaks as there are recognized species. A similar situation has been emphasized by Kerner in the case of European willows. Brainerd has described a large number of hybrid violets, and has resynthesized them by crossing again their supposed parents. Almost numberless examples have been supplied in recent years of natural hybrids of plants in all parts of the world and under all conditions. In animals the situation is as yet not so clear, but hybridism is the most natural explanation of the great variability and numerous species of air-breathing snails, of Orthoptera, Lepidoptera, etc., etc.

A particular case of variability is presented by so-called mutations. Plants and animals presenting this sort of variation which leads to the immediate formation of relatively fixed types (elementary species), present striking features of resemblance to known hybrids, particularly in the meiotic or reduction division. Further, in Leptinotarsa (the potato-beetle), among animals, and in Rubus and in the Brassica-Raphanus cross among plants, known hybridization has been followed by clear mutation.

The unwillingness of certain geneticists to admit the hybrid origin of mutating types is one of the outstanding features of present activity in evolutionary investigation. It is probable that this unwillingness arises out of the fear that the Mendelian hypothesis or the chromosomal hypothesis of heredity would be more or less compromised by such an admission. Certainly hybridism furnishes a satisfactory and sufficient explanation of mutation.

As regards the experimental production of species at the present time, we must choose between the practicality of the experimental production of new species by the action of radiations and by that of crossing. It seems scarcely possible to question the choice which should be made. A very weak point in connection with the production of species by radiations is the fact that there is no good reason to suppose that radiations of sufficient power have been active in this manner to any important extent in nature. Secondly, if such radiations were active, there is very grave doubt, on the basis of existing experimental work, whether they could produce viable species. If we take the other alternative, that of hybridization, we find an overwhelming amount of evidence for its occurrence in nature in all parts of the world and under all climatic conditions. Common sense would seem to indicate that the study of hybrids is much more likely to lead to permanently valuable results in experimental evolution than that of the effect of radiations.

The former generation attributed marvelous powers to electricity, which was then coming into the foreground in practical relation to human affairs. Almost every household attempted to cure itself of the various ills of humanity by the use of electrical appliances, from batteries to electrical belts. At the present time radiotherapy is as prevalent and as popular in the public mind as electrotherapy was a generation or two ago. An outstanding feature of our time is ray-mindedness. The popular exponents of biology have merely found this ray-mindedness an easy line of exploitation. There is no reason to believe, however, that radiations will, in the long run, occupy a higher position in biology, or even the popular understanding of that subject, than does electricity. We must apparently come back, as a consequence, to the sound Darwinian conclusion that environment may select variations but it can not in any important respect give rise to them. This dictum is apparently quite as true for special chemical and physical conditions as it is for the general non-living environment.

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ADSORPTION AND EMULSION FORMATION

If oil and water be shaken vigorously together in a bottle or test-tube, an emulsion is formed which soon separates completely on standing. But if oil and mud be shaken together, the emulsion formed is a thick paste that not only does not disintegrate on standing but resists heating and chemical reagents to a remarkable degree. The oil used may be crude or refined, heavy oil, gasoline or even ether. The mud used may likewise be almost anything: sand, clay, road dirt, metal powder or fibrous dust mixed with water. The mud may be acid or alkaline. Gasoline and clay mud make a convenient pair to experiment with.

We get a clearer picture of what the soil, water and solid particles are doing if we take merely muddy water and shake it up with gasoline. The oil and water now separate clear quite quickly, leaving the solid particles in the form of a thin skin at the interface and on the glass wall. It is quite startling to see a clay suspension, that would not settle clear in months, changed to clear water in a few minutes by shaking with gasoline. The skin formed by the fine particles is quite tough and may be lifted out on a wire like a piece of wet rag. On drying it returns to a powder, indicating that no permanent chemical change has taken place. The solid particles can not spread (like a liquid) at an interface, and being themselves insoluble, can only adsorb the two liquids and mesh together.

Reinders[1] in 1913 made many observations with powdered metals and insoluble salts in water shaken with ether, kerosene, the alcohols, etc., and stated the theory very clearly—the interfacial tension between the two liquids must exceed the sum of the other two. Hofmann[2] about the same time made an extended series of similar observations. Wheeler P. Davey[3] in 1926 read a paper before the Fourth Colloid Symposium giving the theory of the formation of cup grease, which is a carefully prepared emulsion of water, soap and heavy oil. Davey's idea is that the long soap molecules (sodium stearate) in such an emulsion all have their small OH ends turned inward toward the water droplets and their larger CH_3 ends turned outward toward the oil. The meshing together of these bristling units (like hair brushes or chestnut burs) makes a stiff paste of the cup grease. Heating to 250° C. completes the dispersion and removes excess moisture.

The theory of adsorbed polar molecules is hardly sufficient to account for the formation of a tough layer of solid particles at an interface between two liquids. Each particle may be an aggregate of tens of thousands of molecules each but weakly polar in itself. Very clean dry sand easily floats on water, the grains gathering in patches. Here the lighter upper fluid (air) is adsorbed on all sides of the sand grains, causing them to float, and the air layers on adjacent grains tend to coalesce, bonding the grains together. However, in the clay-water-gasoline emulsion, the fine particles of silicates constituting the clay are themselves hydrophilic, hence the assumption of an oil film completely enclosing each grain is untenable.

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[1] Reinders, *Kolloid Zeitschrift*, 13: 235, 1913.

[2] Hofmann, *Zeit. Physik. Chemie*, 83: 385, 1913.

[3] Davey, Fourth Colloid Symposium Monograph, p. 28.

If a mass of clay-water-oil paste be left floating on a soda (washing soda) solution for some time, the silicate particles gradually free themselves from the emulsion and sink. But each drags down with it a tiny droplet of oil, just easily visible with a 10× pocket magnifier, attached to its top. The soda has completely freed the surface of each grain from oil but has *not* destroyed the attraction of the solid particle for the oil droplet. Such behavior is not readily accounted for by either the mechanical or chemical theories of adsorption. An electrical theory would account for it if a particle of one dielectric partly immersed in another had an opposite charge induced on the remaining part. I find no reference to any such law in the literature, but it is plainly consistent with the current theory of dielectrics.

In the oil fields conditions are frequently ideal for emulsion formation. During drilling, oil and mud are intimately mixed by the drill bit. During flowing and pumping, flow through the fine capillaries of the oil sands will produce emulsions if free sand particles and water are present. Such emulsions in most cases represent a dead loss, for there is no efficient chemical method of separating the oil at a reasonable expense. The high voltage electrolytic method (Cottrell process) effectively separates the particles constituting the emulsion but requires expensive apparatus.

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EXCYSTATION OF COCCIDIAL OOCYSTS IN VIVO

WHILE excystation of coccidial oocysts has been observed and deliberately produced *in vivo* by various observers the phenomenon has not been put to the practical use of which it is capable. Segmentation of the oocysts is the usual method of determining the viability of coccidial oocysts, but the limitations of this method lie in the fact that only unsegmented oocysts may be thus tested. Excystation is a reliable criterion of viability that can be used to determine the length of life of oocysts after segmentation, the action of physical or chemical changes in the environment of segmented oocysts or of any other experimental procedure which can be tested by a conclusive manifestation of life within the matured oocyst.

The author has repeatedly carried out excystation *in vivo* using the following simple technique. Segmented oocysts from cats, dogs, guinea-pigs, pigs and prairie-dogs have been used with equal success; probably any species of coccidia from birds or mammals can be used. Young rats (75 to 100 grams) are deprived of food and water for twenty-four hours preceding the experiment. This has the double advantage of making the animal eager to eat and of thoroughly emptying the stomach and small intestine. The ripe oocysts are concentrated by centrifugation. If they have been exposed to any unpalatable chemical which may have been used to prevent putrefaction or for some experimental purpose, the chemical must be removed by dilution with water and centrifugation. The concentrated oocysts are suspended in four or five drops of sweet milk. The material is offered to the starved rat and will be immediately consumed. Sixty minutes after the ingestion of the oocysts, the rat is killed and the intestine is removed. At various points throughout its length it will be observed that the small intestine is distended with white contents. At these points the intestine should be opened and the contents observed microscopically. By examining various places in the intestine, all stages of excystation, if the ingested oocysts were normal, may be found, including motile sporozoites within and outside of the oocysts.

When using this method for experimental purposes, one or more control animals fed with untreated oocysts of the same lot from which the experimental were obtained should be included in the experiment.

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INVESTIGATIONS OF APPLICATIONS OF IODINE

FOR some time past, especially in Europe, considerable research attention has been accorded to the investigation of various proposed uses of iodine. This element, while less fortunate commercially, perhaps, than its congener bromine, which among other industrial applications has achieved importance in the manufacture of a widely used "anti-knock" motor fuel, is known to play a vital rôle in physiology, which fact may lead, it is thought, to the extension of its utility in food and medicine as well as in agriculture. Through the brilliant investigations of Kendall, Harington, McClendon and others, the intricate biochemistry of iodine has received much illumination. There remain, however, many unsolved questions regarding its physiological functions, especially in the lower animals.

These reasons led the Iodine Educational Bureau to establish on January 1, 1928, a multiple fellowship at Mellon Institute. This fellowship, having as its objects the investigation of possible technologic uses of iodine and also collaboration with other institutions interested in research on this element, is headed by

Dr. George M. Karns, who was formerly a member of the chemical faculty at the University of Illinois. All experimental findings of the work will be made available for general use through the scientific journals.

A recent appropriation from the Iodine Educational Bureau has enabled the fellowship to expand its activities by arranging for the study at the Pennsylvania State College of the nutritional functions and value of iodine in the feeding of live-stock. This comprehensive project, begun on September 26, 1929, under the direction of Professor E. B. Forbes, of the Institute of Animal Nutrition, will include studies on cattle, sheep and swine. Such information is much needed, because most of the work on the part played by iodine in metabolism, especially with reference to the thyroid, has been confined to man. Dr. Karns and his associates at Mellon Institute are cooperating in this research, chiefly by preparing standardized feeds.

The institute, acting for the iodine fellowship, has also made arrangements for another investigation under the supervision of Dean Charles H. LaWall, of the Philadelphia College of Pharmacy and Science. A scholarship, which will be held by Mr. L. F. Tice during the college year 1929–30, has been established at that institution for the purpose of making a broad study of vehicles and solvents for iodine with the view of evolving a more satisfactory preparation for medical use than the tincture now employed. A number of new organic chemicals will be studied according to a definite program which has been worked out.

Mellon Institute is also considering, with the advisory aid of a number of pharmacologists, the founding of a medical research scholarship for the purpose of aiding in the solution of questions regarding the utility of iodine in internal medicine. A foundation of this type would, of course, be made in some institution possessing special facilities for such research.

The results of all work, both of the iodine fellowship at Mellon Institute and of the scholarships founded at other institutions, will be made available to the public through scientific periodicals. This procedure is in harmony with the Iodine Educational Bureau's general policy of releasing the findings of all investigations made under its auspices.

LAWRENCE W. BASS

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WHAT IS THE BEST SYSTEM OF PRESENTING BIBLIOGRAPHIES?

IN the issue of SCIENCE for August 30, 1929, Dr. J. L. St. John very appropriately calls attention to the desirability of a more uniform system of presenting bibliographies in the various scientific journals. With reference to the name-number and name-date systems of citing literature, however, he says "It would seem that the advantages of the name-date system justify its use in practically all cases" and "A number associated with the author's name has no value except in helping locate the reference in the bibliography." In view of these statements it seems desirable to call attention to the other side of the question. As there are journals, editors and writers who prefer the name-number system there must be good reasons for using it.

A working corollary of the name-number or numerical system is that the list of literature citations is arranged alphabetically. This arrangement, however, is only an additional advantage of the system and can be disregarded if it is preferred that the numbers be assigned to references in the order in which the references appear in the text or in chronological order or in the order of importance or in any other order determined upon. Aside from the convenience attaching to the use of numbers in the list of references, the major advantage is derived from their use in the text.

To give one of many examples of this advantage, I quote from a comparatively recent publication: "This is fully covered in the literature (2, 8, 14, 17, 18, 20, 22, 25, 29, 32, 41, 59, 60, 61, 64, 66, 68, 83, 85)." If these citations had been given according to the name-date system the following would have been the printed result: "This is fully covered in the literature (Anonymous [1903]; Atlantic City Academy of Medicine [1902]; Banks [1927]; Broadbent [1895]; Brooks [1916]; Bulstrode [the date of publication was 1904, but the report covered in this instance was for 1902–03]; Bundesen [1925]; Chantemesse [1896]; Conn [1895]; Eade [1895]; Harris [1925]; Lankester [1885]; Lumsden, Hasseltine, Leake and Veldee [1925, but the report was for the year 1924–25]; Marvel [1903]; Mosny [1899]; Newsholme [1903]; Pease [1911]; Stiles [1912]; Thresh and Wood [1902])."

In addition to the increased volume of text and expense of publication there is the greater liability of citation errors when so many names and dates are included. Not infrequently an author gives group citations many times in his paper. The page references are sometimes included in the group citations, and there may also be several citations of the same year or of different years from the same author. In the latter case it is necessary to differentiate between the citations of the same year from one author by the addition of the letters a, b, c, etc., thus further complicating the situation. Another objection to the name-date system occurs in connection with the citations of the proceedings of some society whose meetings are held one year but whose publication is not accomplished until the following year. Furthermore, some bound volumes of periodicals cover publications of two years, or the last half of one year and the first half of the succeeding one. Accuracy and clearness become serious problems in the textual citing of such references according to the name-date system. In comparison with that system the numerical system has the advantage of being concise, accurate, definite and less expensive, and the numbers are easily inserted, inconspicuous, and their use in a small space does not distract the reader's attention from the subject-matter of the text. These advantages become especially evident in a paper containing many references to the same citation. Finally, the use of the numerical system permits the inclusion in the text of whatever names and dates are required.

An objection that is sometimes raised against the numerical system is that after a manuscript has been prepared, particularly when it reaches the galley-proof stage, the author finds another reference which he very much desires to add. If the name of the author of the new reference happens to begin with W or Y there may not be much difficulty in making the insertion, but if it unfortunately begins with A or B there may be trouble, especially if the list is long. An easy solution for this difficulty is to designate the new reference by a numbered letter. Thus if the previous citation in the alphabetical list is number 3, the inserted one may become 3a without any serious disturbance. If the list is not arranged alphabetically, and of course that arrangement is not a positive necessity when numbers are used, the insertion of new references could easily be made at the end of the list and numbers assigned accordingly.

M. C. MERRILL

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SCIENTIFIC BOOKS

The Platinum Deposits and Mines of South Africa. By DR. PERCY A. WAGNER. Oliver and Boyd, Edinburgh. 38 full-page plates, 3 maps, 37 text illustrations. 326 pp. Price 21s.

WHILE this volume discusses primarily the deposits of the Transvaal, it also includes those of the Cape Province and southern Rhodesia, which are closely related geologically with those of the Transvaal. The South African deposits have been much in the limelight since their discovery about four years ago, and this detailed exposition of the local situation by one so thoroughly versed in it will be welcomed by all interested in the subject. The story as related by Dr. Wagner is a marked tribute to Dr. Hans Merensky for the ability he displayed in opening up the new field, for he not only discovered both the dunite deposits and the Merensky Horizon in the Lydenburg district, as well as the more important locations in the Potgietersrust area, but also succeeded in locating the Merensky Horizon in the Rustenburg district after others had abandoned all hope of finding it.

It is with keenest regret that I have learned of the death of Dr. Percy A. Wagner, who was stricken with typhoid fever and died on November 11, 1929. He was one of the most talented men who has ever visited the great southern part of South Africa, and had just entered into a contract for five years to do mineral surveying, after having been director of the survey and doing much original work.

Dr. Wagner first discusses the sources of supply, the properties and uses, and the range of prices of the platinum metals. Several years ago some of the gold mines of the Rand developed methods of saving the small amounts of osmiridium that occur in these ores, and soon brought the union into the position of leading producer of this rare combination of metals. A few years later, the platinum deposits were discovered, and since the beginning of the industry in 1925 South Africa has reached third place as a producer of platinum group metals, being exceeded only by Russia and Colombia. For a number of years Canada has been producing a gradually increasing amount of the platinum metals as a by-product in the treatment of nickel ores, but yielded third place to South Africa in 1927.

Before the discoveries in South Africa, the occurrence of platinum was considered to be standardized as an alluvial product. While some was obtained as a by-product in the treatment of the ores metals, particularly nickel and copper, none was regularly obtained from ore mined *in situ* for the sake of its platinum content. As found in nature, the metal was seldom in the pure state, but usually occurred as an alloy of platinum with other metals of the platinum group and with iron; sometimes these were accompanied by gold, copper, nickel or cobalt. With the exception of these native alloys, only two minerals of the platinum metals were known: sperrylite, the arsenide of platinum, and laurite, the sulphide of ruthenium and osmium, and both of these were very rare. The former was found in the Canadian nickel ores and the latter in the platinum-bearing gravels of Borneo. In South Africa, then, for the first time, ores were found *in situ* in which platinum was found in sufficient quantity to justify treatment for the recovery of the platinum content. These ores have not only given us our first extensive treatment of lode ores for platinum but have also contributed several items of more than ordinary interest in the mineralogical history of the metal. In addition to the native alloy minerals present in the ores, they contain platinum and palladium in a colloidal state, as well as various compound minerals. These ores have not only yielded single crystals of sperrylite up to 33.75 grams in weight (several hundred times larger than any previously known), but have also given us two new minerals: cooperite, a sulph-arsenide of platinum, $Pt\ (As,\ S)_2$, and stibiopalladinite, a palladium antimonide, Pd_3Sb. The ores of the Potgietersrust district are particularly rich in these compound minerals, while those from Lydenburg and Waterberg show mainly the alloy minerals. The presence of these colloidal metals and new minerals introduced new and difficult problems into the ore dressing and metallurgical treatment of the ores and are largely responsible for the delay that has been encountered in the development of the industry.

These South African platinum deposits present a unique chapter in economic geology, from every angle from which they may be viewed: chemically, mineralogically, geologically and geographically. The metals are found in both the free and the combined form and in association with both acid and basic rocks; they are found in all types of deposits: clays, sands, river gravels, marine beds, sandstones, quartzites, conglomerates and a variety of others; they are found in rocks of all ages, and in distribution they occur in a well-defined area reaching from the Insizwa Range in eastern Cape Province, north and east through the Black Reef, the Witwatersrand gold fields, the norite zone of the Bushveld Igneous Complex and the Waterberg district of the Transvaal, and on throughout the length of the Great Dyke of Southern Rhodesia, a total distance of about one thousand miles, giving what the author designates as "a great *platinum belt* that cuts indiscriminately across the oldest and youngest geological formations, completely disregarding geological structures and structure lines in the more superficial parts of the earth's crust."

The wide-spread occurrence of the platinum metals under such a variety of conditions is clearly a result of an underlying cause that has continued to operate throughout the various stages of geological time. According to Suess, the *sima* zone, a thick peridotite shell underlying the upper layers of the continental crust, is the principal home of the platinum metals. This would indicate that the *sima* zone underlying this portion of South Africa is abnormally rich in platinum which has been transferred to the surface layers of the crust. According to Spurr's conception of "ore canals" there should be here a great platinum canal that from earliest times has facilitated the upward transference of the platinum metals from the *sima* zone to the rocks of the overlying crust. Dr. Wagner predicts further discoveries of platinum along the course of this canal.

In the discussion of the less important sections of the platinum-bearing zone, three pages are devoted to the ultrabasic and basic rocks of the Swaziland system, nine pages to the Black Reef and the Rand, six pages to the Great Dyke, eleven pages to other minor sections and three pages to the eluvial and alluvial deposits; the bulk of the discussion, however, (165 pages) is concerned with the details of the deposits of the Bushveld Igneous Complex, associated with dunite, olivine, olivine-dunite, chromitite, magmatic nickel-copper-iron sulphides and particularly with the norites of the Merensky Horizon.

From a purely scientific standpoint, one of the most interesting sections of the book is the chapter contributed by Dr. H. Schneiderhöhn, of Freiberg, on the mineragraphy, spectrography and genesis of the Bushveld ores. This includes a study of eleven specimens from the Rustenburg district, seventeen specimens from Lydenburg and sixty-five specimens from Potgietersrust; mineragraphical observations on the occurrence of the platinum metals in the nickel-pyrrhotite-bearing rocks of the Bushveld Complex; a detailed description of the mineragraphy of sperrylite and the two new minerals, cooperite and stibiopalladinite; an account of the examination of various specimens for the platinum metals by the quartz spectrograph and ultra-violet light, and a summary of results and conclusions as to the genesis of the ores.

According to Dr. Schneiderhöhn these ores have passed through four phases in their formation: first, the earliest crystallization from the magma of such minerals as chromite, magnetite, etc.; second, the separation of the liquid sulphide melt from the silicate-oxide melt, and the crystallization of the sulphides; third, the crystallization of the residual solutions, and fourth, liquid exsolution-segregation and pegmatite formation. During the second of these stages the platinum metals entered into the crystal lattices of the iron-nickel sulphides and crystallized with them; during the third stage the temperature was too low to permit this, and the platinum metals were forced to crystallize separately, as sperrylite, cooperite and stibiopalladinite.

The problems involved in the mining of these deposits were soon solved, but the difficulties in ore dressing and metallurgical treatment were not so readily disposed of, and it is only within the last year that really satisfactory methods have been developed.

In the months immediately following the discovery of the scope of the South African deposits, it was freely predicted that within three years the union would be the leading platinum producer of the world. That this has not been more nearly realized is due chiefly to the unprecedented difficulties encountered in the treatment of these new ores. Decided progress has been made, however, particularly within the past year, and another year should show pretty definitely what is to be the status of South Africa in the world's platinum industry. In 1928 the production was 23,600 ounces of platinum metals from three treatment plants totaling 300 tons of ore per day; three more are under construction with a daily capacity of about 800 tons of ore, and this should provide a potential capacity of more than 100,000 ounces of platinum metals a year.

It still remains to be seen how much South African platinum the world can absorb, and at what prices. To secure a market for anything like the maximum capacity will mean strenuous competition against Russia and Colombia, and from increasing amounts of by-product metals from Canadian nickel ores. To accomplish this through a price war would mean the sacrifice of much or all of the profits of all producers for several years to come. The only alternative is international cooperative restriction of output at a stabilized price, and there seems little prospect of accomplishing this at the present time. It is possible, however, that the country that produced a diamond syndicate that has successfully maintained its existence for thirty years may find a solution of this similar, but possibly more difficult, problem.

One of the chief requirements for the future success of the industry is an increase in the present rather limited demand, by the development of new uses. Russia already has a platinum institute for the fostering of her industry, and Dr. Wagner advocates the appointment of a committee of scientific and commercial men for the same purpose in South Africa, the necessary funds to be supplied by the government and the mining companies controlling the industry.

The volume is concluded by an excellent bibliography of platinum covering the last twenty years. The entire volume is well printed, and is illustrated by thirty-seven figures in the text, and thirty-eight plates, three of which are geological maps of the Bushveld, Rustenburg and Potgietersrust districts. Typographical and other errors in the text might almost be said to be conspicuous by their absence.

George F. Kunz

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN ELECTRIC KYMOGRAPH[1]

The aluminum box shown in Fig. 1 contains four shafts. Shaft No. 1 is at the back of the box and extends only to the block opposite the disk on which the drum will rest. Shaft No. 2 is at the front and extends from the partition enclosing the motor all the way to the right-hand wall of the box. Shaft No. 3 is on the right-hand side at the back of the box, and shaft No. 4 is just in front of No. 3.

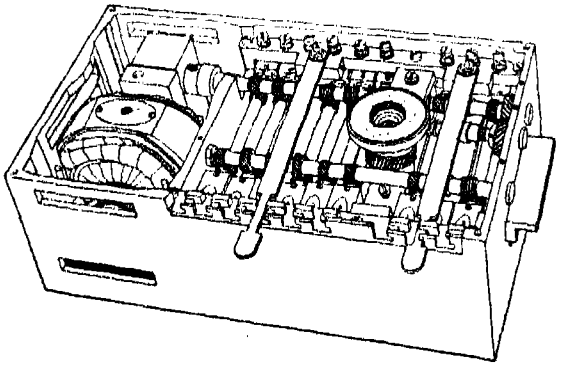

Fig. 1

Above the shafts are seen two levers, pivoted at the back. The left-hand lever may readily be moved into any one of six slots on the middle portion of the front wall of the box, and the right-hand lever may as readily be placed in any one of three slots on the right-hand portion of the front wall. Each slot is double—a front and a back slot. And each slot is undercut on the right-hand side. In Fig. 1, the left-hand lever just mentioned lies free in the open part of slot 4, whereas the right-hand lever is engaged beneath the overhang left by undercutting the middle one of its own group—the three right-hand slots. The left-hand lever in Fig. 1 can be lifted out of its slot directly, but the right-hand lever in Fig. 1 fits snugly in the undercut and must be moved to the left in order to free it. Obviously, the left-hand lever can be engaged in any one of its six slots and the right-hand lever can be engaged in any one of its three slots at the operator's will. Indeed, these levers may be moved from one slot to another in one or two seconds.

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[1] This new kymograph was first given "public use" by Professor Charles W. Greene in his laboratory at the University of Missouri, Columbia, Missouri, January, 1929. The kymograph was formally demonstrated to the members of the Thirteenth International Physiological Congress in Boston, Wednesday, August 21, 1929. It will be found on page 37 of the official program under the title "An Electric Kymograph, by W. T. Porter."

At the back of each pair of slots, beneath the overhang, is the round head of a metal pin. When either one of the two levers is moved to the right and so is pushed beneath the overhang of a slot, the lever necessarily presses on the top of this pin, forcing it downwards. This pin in turn presses on an adjustable pin in a rocker arm, one of which is shown in Fig. 2. There is a rocker for each slot. When the pin is pressed down the rocker tilts up and its two gears engage with gears upon shafts No. 1 and No. 3. The group of six rockers (left hand) engages with shaft No. 1, and the group of three (right hand) engages with shaft No. 3. The large group (six) is controlled by the left-hand lever, and the small group (three) is controlled by the right-hand lever.

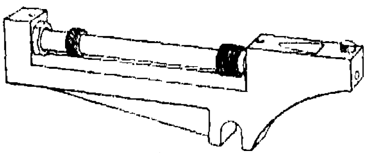

Fig. 2

Let us now start the motor and thus cause shaft No. 1 to revolve. By engaging the left-hand lever in any one of its six slots, shaft No. 2 will also revolve. The gears on each of the six rocker arms governed by this lever are so related to the gears of shafts No. 1 and No. 2 that shaft No. 2 may revolve at six different speeds, the fastest when the lever is engaged in the left-hand slot.

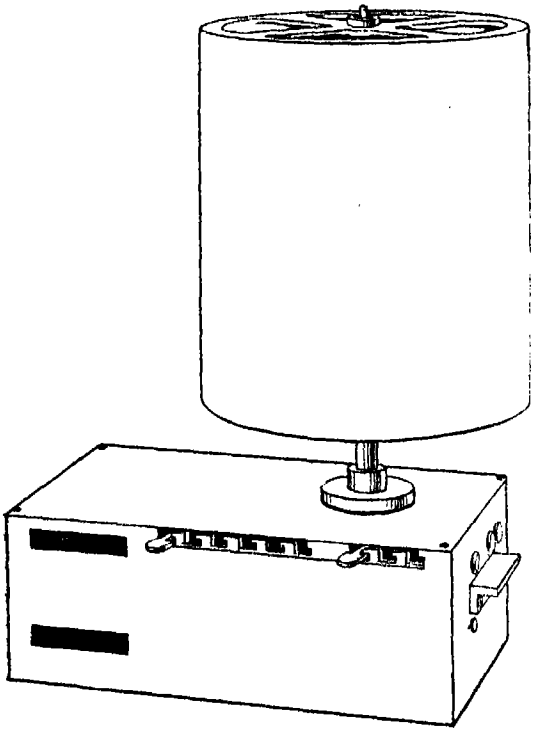

Fig. 3

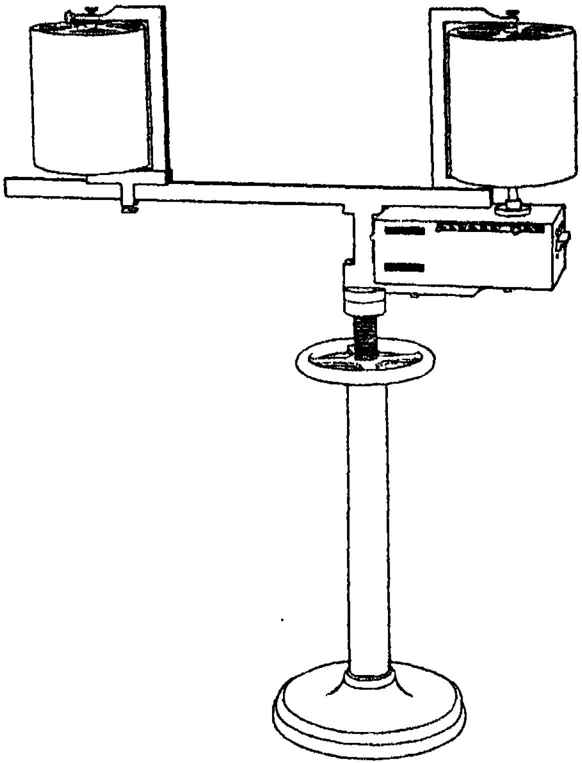

Fig. 4

So we have caused shaft 2 to revolve at any one of six speeds. Meanwhile, the smoked drum is unmoved. It does not turn until the revolutions of shaft No. 2 are carried to shaft No. 3, and thus to shaft No. 4, which last turns the disk on which the drum rests. But the six different speeds of shaft No. 2 are either increased or diminished in their passage to shaft No. 3. When the right-hand lever is engaged in its middle slot (as in Fig. 1), a gear of the middle rocker arm connects with a gear on shaft No. 3 in such a way as to produce a medium set of speeds; when engaged in the left-hand slot, fast speeds will result; and by putting the right-hand lever in its right-hand slot, slow speeds may be had. In each set (fast, medium and slow) there will be six possible changes, one for each position of the left-hand lever. The operator has therefore a choice of eighteen speeds. With a motor giving 1,725 revolutions per minute, these eighteen speeds are as follows:

Fast and Medium Speeds
In millimeters per second

Fast	100	75	50	30	20	10
Medium	10	7.5	5	3	2	1

Slow Speeds
In centimeters per hour

Slow	50	38	25	15	10	5

When the clockwork is used to drive one drum only (Fig. 3), the slowest speed is one revolution in fourteen hours. When two drums are used (Fig. 4), connected by a paper belt about 2.6 meters long, the slowest speed is one revolution in about fifty-two hours. Naturally, the speeds vary with the motor used. The cylinders are 25 cm high and 70 cm in circumference.

As stated above, disengaging the right lever stops the drum, which may then be turned to right or left in order to inspect the tracing or adjust the recording instruments.

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SPECIAL ARTICLES

A POSSIBLE RELATION BETWEEN NATURAL (EARTH) RADIATION AND GENE MUTATIONS[1]

THE discovery three years ago that X-rays and radium produce gene mutations under laboratory conditions has raised the question of how mutations in nature occur.

Muller,[2] Olson and Lewis,[3] Haldane[4] and others have suggested that possibly radiations from the earth, or even cosmic rays, may have played an important rôle in the evolution of species by furnishing heritable variations upon which natural selection may act. It is not improbable that in earlier times radioactive substances were distributed over the earth rather differently than they are to-day and may have been more powerful, as evidenced by the quantity of their end products, helium and lead, now present in the earth. Joly[5] has suggested that cosmic rays may change in intensity and infers that we may be now at the low ebb of a cycle of cosmic radiation. He ties up this decrease of cosmic radiation with the increase of cancer in recent times. Haldane[4] says that "mutants are produced in large quantities by X-rays, and it may be that much of normal mutation is due to the beta and gamma rays from potassium, other radioactive substances and cosmic radiations."

Olson and Lewis[3] were among the first to point out the desirability of testing experimentally the effects of natural radiation upon organisms. According to them, the rays are effective only when absorbed with resulting ionization. Hence the biological effects will be in proportion to the amount of ionization they set up. The above suggestions inspired at least two geneticists to put the matter to an experimental test.

Working independently, Babcock and Collins[6] and the present writers performed almost identical experiments to test this point. Using an electroscope Babcock and Collins discovered a location in a street-car tunnel in San Francisco where the natural ionizing radiation was fully twice as great as the radiation in their laboratory in Berkeley. Accordingly their experiment was designed to compare the rates of occurrence of sex-linked lethal mutations in *Drosophila* in the street-car tunnel and in the laboratory. Three thousand four hundred and eighty-one tests were made in Berkeley, and nine, or 0.26 per cent., produced no male flies and hence showed the occurrence of that many new lethals. Two thousand five hundred tests made in the tunnel gave thirteen, or 0.52 per cent., of lethal mutations. While the difference in rate, 2.5 times the probable error, is not fully significant statistically, it is believed by these authors that it may be fairly so considered. Upon a reanalysis of the data showing the actual experimental variation in rate in the several subgroups in each of the two series it was found that the difference between the average rates for the two locations was increased. This difference was 0.275 ± 0.086.

The present writers, in accepting the implied challenge to experiment contained in Olson and Lewis's paper, considered themselves suitably located for such an undertaking, *i.e.*, near the Ozark caves and lead mines of Missouri. But a long search with the electroscope in the numerous caves and lead mines of this region failed to reveal a location with a sufficient increase of ionization over that of the laboratory, or the middle of a Missouri corn-field, to justify breeding experiments.

Operations were then transferred to Colorado. There in the East Paradox Valley of western Colorado in an abandoned carnotite mine the air was strongly ionized. In addition to the electroscope readings a rough attempt was made to compare the amount of natural ionization in this mine with that of one mg of radium. Radiation in the mine was found to be 0.39 times as intense as that from one mg of radium when the rays were passed through a 0.156-inch lead filter.

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[1] The expenses of this investigation were met in part by a grant from the committee on the effects of radiation upon living organisms of the National Research Council.

[2] H. J. Muller, "The Problem of Gene Modification," *Verhandlungen des V. Internationalen Kongress für Vererbungswissenschaft*, Berlin, 1928, pp. 234–260.

[3] A. R. Olson and G. N. Lewis, "Natural Radioactivity and the Origin of Species," *Nature*, 121: 673–674, 1928.

[4] J. B. S. Haldane, "The Species Problem in the Light of Genetics," *Nature*, 124: 514–516, 1929.

[5] J. Joly, "Cosmic Rays and Cancer," *Nature*, 124: 579, 1929.

[6] E. B. Babcock and J. L. Collins, "Natural Ionizing Radiation and the Rate of Mutation," *Nature*, 124: 227–228, 1929.

Male flies were exposed in this mine for 140 hours and then returned to St. Louis for the breeding tests. The well-known ClB method for detecting lethal mutations in the X-chromosome was employed.

In this technique lethals are revealed in the F_2 cultures. There were 2,860 test cultures, of which seven, or 0.245 ± 0.062 per cent., produced no male flies. In the 1,308 control cultures there was one lethal mutation, or 0.076 ± 0.051 per cent. The difference between tests and controls is 0.169 ± 0.081, a difference 2.09 times its probable error.

While this difference is theoretically not statistically significant it actually may be so. It is highly probable that if the flies could have been exposed for a much longer period than the 140 hours the results would have been more striking. This was impossible in this instance as the time consumed in taking the flies to Colorado and back, together with finding a suitable location there for the test, used up a considerable portion of their life span. The results secured, however, point to much greater success when the experiment can be repeated, hatching the flies, exposing them for several weeks and breeding them for results at the mine. Or a second possibility seems equally promising, namely, from the electroscope readings in the carnotite mine exactly equivalent amounts of radiation can be duplicated in the laboratory and the time of exposure extended accordingly.

These two experiments, one in California and one in Colorado, while falling short of being statistically significant, nevertheless are consistent in that both give an actually higher rate of mutation in flies exposed to natural radiation than in the controls. The least that can be said for the results is that they strengthen definitely the plausibility of the suggestions quoted above to the effect that natural radiation may be responsible for the mutations which are the grist of the natural selection mill with the resulting evolution of new forms.[7]

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FLORENCE HEYS
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THE EFFECT OF VARYING THE DURATION OF X-RAY TREATMENT UPON THE FREQUENCY OF MUTATION

IT has been shown repeatedly that X-rays produce variations. We need now to learn more about the nature of the X-ray action in producing these variations, and to obtain further evidence regarding the question whether or not such dilute amounts of radiation as are present in nature might be expected to be producing the mutations found in nature. As a step in that direction, this experiment was begun, in the early part of 1928, at the suggestion and under the supervision of Dr. H. J. Muller, to find the relation between different doses of X-rays and the resultant effect upon the individuals—more definitely, to get the relation of dosage to the frequency of sex-linked lethal mutations produced in *Drosophila melanogaster,* and to analyze the results found.

The different dosages varied only in the length of time of treatment. All other factors were kept as nearly constant as possible. Adult males having the autosomal characteristic brown-eye were collected and kept at 27° C. for at least three days before treatment. The experiment was divided into four series in each of which the flies were divided in about the same proportions among the different dosage groups. All the flies, including the controls, were handled similarly except for the time of treatment. After treatment, these males were mated to virgins containing ClB in one X-chromosome and scute vermilion forked in the other, and after seven days these P_1 flies were discarded. The F_1 bar-eyed (ClB-containing) females were mated to their brothers. Normally half the F_2 males die because of the lethal in the ClB combination. Now if a lethal had arisen by treatment of the X-chromosome of the P_1 male, there would be no F_2 males appearing. However, it is necessary to check these apparent lethals in the F_2 cultures by further breeding in order to be certain that the no-male result was due to a lethal and not to other conditions. For that purpose, the non-bar-eyed F_2 females in the apparently lethal cultures were mated to scute vermilion forked males. Only the cultures showing a lethal in these F_3 results were recorded under column three in the table given.

The results are tabulated briefly in the following table in which "dosage" refers to duration of treatment: t_1 lasted three and one half minutes; t_2, double that time, etc. As previously indicated, the total number of lethals is based on the F_3 results from the matings of the non-bar females by sc v f males. The "per cent. of observed lethals due to treatment" is found by subtracting the control lethal per cent. (0.24 ± .051) from the per cent. found for each dosage. The "ideal per cent." is calculated from the

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[7] We take this opportunity of expressing our appreciation to Dr. R. D. George, state geologist of Colorado, for his many helpful suggestions which led to the finding of what must be one of the most radioactive locations in Colorado; also to Mr. R. S. Blitz, of the Vanadium Corporation, who kindly permitted the tests to be made in the carnotite mine. Mr. Walter D. Claus, of the physics department of Washington University, constructed the electroscope and made the ionization tests.

Dosage	Number fertile F_2 cultures	Total number lethals	Per cent. observed lethals due to treatment	Ideal per cent. lethals
t_{16}	435	70 ± 5.19	15.85 ± 1.19	18.07 ± .7
t_8	618	61 ± 4.57	9.63 ± .74	9.49 ± .4
t_4	1144	55 ± 4.89	4.56 ± .428	4.86 ± .2
t_2	2231	72 ± 5.63	2.99 ± .256	2.46 ± .1
t_1	4016	57 ± 5.04	1.18 ± .135	1.24 ± .05
Control	4033	10 ± 2.13		
Total	12477			

X-ray dosage: 50 KV; 10 MA; 13½ cm distance; 1 mm Al screen; time varies as indicated; t_1 approximately 285 r units.

equation based upon the law of probability: $\log q = kt$, in which q is the proportion of escaping (non-lethal) cells, t is the time of treatment and k is a constant. From this equation the mean value of k is found, and the ideal values for all the doses used are calculated from that.

The results show a significant increase in the per cent. of lethals each time the dosage is doubled, and with each dosage, the per cent. of corrected observed lethals approaches closely the ideal per cent., that is, the per cent. that would be expected based on the results as a whole, if the above equation held true. That there is a direct proportionality between the per cent. of lethals and the length of time of treatment may be seen more readily by a comparison of the t_1 values calculated from the results for each of the given doses. These values are calculated, based on the proportion of escaping cells, by using the formula previously given. The mean t_1 value is found to be 1.24 ± .05; t_1 values calculated from the results for each of the given doses are found to be: t_1 based on t_1 result $= 1.18 \pm .13$; t_1 based on t_2 result $= 1.506 \pm .13$; t_1 based on t_4 result $= 1.162 \pm .11$; t_1 based on t_8 result $= 1.26 \pm .10$; t_1 based on t_{16} result $= 1.074 \pm .09$.

A comparison of these values with the mean t_1 figure shows that the values based on the t_1, t_4 and t_8 doses approach closely to this mean; those of the t_2 and t_{16} vary more, the former being larger and the latter smaller. However, in each case, the difference between the observed and ideal values falls within twice its own probable error, an event to be expected once in about 5.5 trials, on the average, and hence not surprising in two of our five batches.

In the analysis of the F_2 cultures one finds some in which there is a significant decrease in crossing-over. Some of these are lethal in effect and so were recorded as lethals in the table; however, there was such a lack of crossing-over that it was impossible from our recorded results to locate the lethal or to say just what kind of lethal it was. For the present these are classed as "chromosome abnormalities" (CA). The two higher doses have a much greater per cent. of the CA lethals than do the three lower doses. We found, corrected, 4.88 per cent. of such CA's in the t_{16}, 2.204 in t_8, 0.377 in t_4, 0.403 in t_2, 0.075 in t_1 and none in the control. Calculating the t_1 value from these, the average for the two higher doses is .292 ± .0465, and for the three lower doses, .124 ± .029. There is, then, a difference of .168 ± .037. This difference is 4.5 times its probable error, and this is apparently significant. However, it may be that some of these CA's are due to double lethal point-mutations or to lethal point-mutations combined with semi-lethal or poor-viability genes. Tests are now being made, to be reported later, by which to analyze them. The effect of dosage on the frequency of CA's can not be conclusively given till these tests are completed.

Regardless of the results for the CA's, it is important to note that the total number of lethals is directly proportional to the dosage used when the only factor varied is the duration of treatment. There is no indication of a threshold dosage below which mutations would not be produced. In so far as this work goes, it therefore indicates that the small amounts of radiation in nature may cause some or all of the natural mutations. Since the suggestion of this possibility and of the method of testing it by measurements of mutation frequency in the presence of different dosages of radiation was made by Muller,[1] Olson and Lewis[2] reported calculations indicating that in tobacco the frequency of "variations" under natural conditions bore about the same relation to their frequency following X-ray treatment as did the amount of ionization in nature to that caused by the X-raying. It is, however, uncertain whether or not gene-mutations were predominantly involved in this work and whether the types of variation in the two cases were comparable genetically. A few months later Hanson and Heys[3] obtained results in favor of the interpretation that natural radiation caused natural mutations, since their data on beta and gamma rays of radium, like the independent work on X-rays reported above, showed a proportionate relationship between dosage and mutation frequency. Stadler[4] on the basis of preliminary experiments on barley has tentatively reported an apparently similar relation between X-ray dosage and mutational effect. Still more recently Babcock and Collins[5] have reported preliminary results that point in the same direction, in that they find a difference in mutation frequency between two series of flies subjected to differing amounts of natural radiation which is 2.5 times its own probable error. The chance of occurrence of such an outcome if there were no real effect is 1 to 10. In their work, owing to the small numbers of mutations necessarily obtained with such dilute radiation, there can as yet be no question of showing a proportionality between mutation frequency and radiation. However, the concurrence of the evidence from all the above sources is noteworthy.

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[1] H. J. Muller, "Artificial Transmutation of the Gene," SCIENCE, 66, 84–87, 1927; "The Problem of Genic Modification," *Verhand. d. V. Int. Kong. f. Vererb.*, Berlin, 234–260, 1927; "The Production of Mutations by X-Rays," *Proc. Nat. Acad. Sci.*, 14: 714–726, 1928.

[2] A. R. Olson and G. N. Lewis, "Does Natural Ionizing Radiation Control Rate of Mutation?" *Nature*, 121: 673–674, 1928.

[3] F. B. Hanson, "An Analysis of the Effects of Different Rays of Radium in Producing Lethal Mutations in Drosophila" (Abstr.), *Anat. Rec.*, 41: 99–100, 1929; F. B. Hanson and F. M. Heys, "An Analysis of the Effects of Different Rays of Radium in Producing Lethal Mutations in Drosophila," *Am. Nat.*, 63: 201–213, 1929.

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OVARIAN CHANGES DURING PREGNANCY IN THE RAT

IN an earlier issue of SCIENCE, Nelson[1] reports the recurrence of oestrus cycles four days in length with copulation taking place at three of the oestrus periods in a pregnant white rat. Two instances of copulation during pregnancy had been reported by Long and Evans,[2] though no evidences of the normal oestrus cycle were noted. In the later report no attempt was made to determine the occurrence of ovulation.

In a preliminary communication[3] we have noted the occurrence of ovogenesis during adult life in the mammalia as a rhythmical production which coincides with the rhythm of the oestrus cycle. In each oestrus cycle a new crop of follicles is formed and a few grow to maturity. At each oestrus period ovulation takes place, and all the other follicles degenerate within a short time thereafter. We have found that this cycle of ovogenesis in the rat is not interrupted by pregnancy, but continues throughout with the usual four or five-day periods. At the end of each period ripe follicles are present with many smaller follicles showing all stages of degeneration. With the beginning of the new cycle at the fifth, the tenth, the fourteenth and the eighteenth days, or thereabouts, newly formed corpora are found, some of which contain a segmenting ovum. These corpora are seldom more than a third of the size of the corpora of pregnancy, and are often much less than that. The number of large follicles produced at each cycle varied from two to twelve in the seventy-six rats that were examined at all stages of pregnancy from the third day to full term. The number of small corpora showed about the same range of variation though occasionally small follicles were luteinized.

No changes in the uterus corresponding to those of the non-pregnant oestrus cycle were observed. The living animals were not examined by means of the vaginal smear method. This has been done in hundreds of pregnant rats in our laboratory, however, without detecting the typical oestrus changes, though it has been noted for many years that at day five the smear loses its typical appearance, resembling a prooestrus smear, especially in the reduction in leucocytes, though it is not followed by cornified cells. In their studies of the uterus of pregnant rats, Long and Evans[2] found no evidence of cyclical changes. No eggs were found in the tubes, though comparatively few of the corpora showed a retained egg.

Twenty-three of these rats were tested for oestrus behavior by being placed in a cage with an active male on the fifth day. No evidences of oestrus were observed and copulation did not take place in a single instance, as shown by the absence of plug and sperm when examined on the following day.

There is no evidence in these animals that the corpora lutea of pregnancy have any effect on the production of a normal number of follicles and their maturation. The evidence also shows that the cervical stimulation of copulation at the beginning of pregnancy did not result in the delayed production of mature follicles, as these were present at the fifth day in eight rats. It also indicates that the presence of fairly large follicles in the ovary is not sufficient to produce oestrus changes in the uterus or oestrus behavior in the animal, although corpora lutea are actually developed from such follicles. Cyclical changes thus occur in the ovary during pregnancy, a condition which has hitherto been supposed to suspend those changes.

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[4] L. J. Stadler, "The Rate of Induced Mutations in Relation to Dormancy, Temperature and Dosage" (Abstr.), *Anat. Rec.*, 41: 97, 1928.

[5] E. B. Babcock and J. L. Collins, "Does Natural Ionizing Radiation Control Rate of Mutation?" *Proc. Nat. Acad. Sci.*, 15: 623–628, 1929.

[1] W. O. Nelson: "Oestrus during Pregnancy," SCIENCE, 70: 453, November 8, 1929.

[2] J. A. Long and H. M. Evans: "The Oestrus Cycle in the Rat and Its Associated Phenomena," Mem. Univ. Calif., Vol. 6, 1922.

[3] O. Swezy and H. M. Evans: "Ovogenesis in the Mammalia," *Proc. Exp. Biol. and Med.*, Vol. 27, 1929.

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PROBLEMS OF THE GLACIALIST[1]

By FRANK LEVERETT

A year ago, at the New York meeting of this association, I discussed the Pleistocene glaciation of the northern hemisphere, as a contribution to the symposium on the centenary of glacial geology. This year I will take up some of the problems confronting the glacialist. Last year's paper outlined the results of past work. The present paper endeavors to outline future work. Some of the problems are matters of local application, but the majority of those here considered are of world-wide bearing.

The Problem of Glacial Epochs

Inasmuch as the normal climate of the earth has been non-glacial the cause for glacial epochs has excited wide interest, and its solution has been attempted by a wide range of students, including astronomers, physicists and biologists, as well as geologists and climatologists. Unfortunately, the climatologists, who should be the leaders in this study, have been baffled by the complexities of climatic factors. They differ widely in the interpretation of present climate, as well as in that of past climates. Some of the leading ones have opposed their speculative views to the plain teaching of observations on the existing ice-sheets, as has been clearly shown by Hobbs in his recent book on the glacial anticyclones.[2] The doctrine of circumpolar cyclones, to which Ferrel Maury and James Thomson contributed in the 1850's, was still supported by Hann in 1897, when he wrote in his "Klimatologie" (p. 543):

> The whole Antarctic circumpolar area presents us, as already stated, with a vast cyclone, of which the center

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[1] Address of the retiring vice-president and chairman of Section E—Geology and Geography, American Association for the Advancement of Science, Des Moines, Iowa, December 30, 1929.

[2] "The Glacial Anticyclones: The Poles of the Atmospheric Circulation," Univ. of Michigan Studies, Scientific Series, Vol. IV, 1926, by William Herbert Hobbs.

is at the pole, while the westerly winds circulate around it.

After observations on the Antarctic continent by members of Scott's expedition had clearly indicated that an anticyclone, and not a cyclone, lies over that continent, Hann, in correspondence with the British Meteorological Office, granted the presence of an anticyclone on the immediate surface of the continent, but maintained that at a moderate elevation the cyclone must reestablish itself, there being no chance for the existence of a real continental anticyclone. Because of the strong influence of Hann the true significance of the anticyclonic winds was not grasped by the members of that expedition, nor by Sir Napier Shaw, the director of the British Meteorological Office, who prefaced the report on meteorology by a statement consistent with Hann's idea of a shallow anticyclone. Meinardus has similarly interpreted results of the German expedition under Drygalski. When speculative ideas thus control the interpretations of observers it is no wonder that progress has been slow toward a proper understanding of our present climate. Such an understanding will be difficult enough if observation is made the basis for interpretation. In this connection I would remark that the existing ice-sheets probably hold the key to a proper solution of the climatic conditions of the glacial epochs. The striking difference between the polar and equatorial regions which prevails to-day is in sharp contrast to that of the non-glacial periods and represents the waning phase of the Pleistocene glacial epoch. The existing ice-sheets also are likely to throw light upon the method of growth and the movement of the Pleistocene ice-sheets. Rapid advance in our knowledge may be expected now that the aeroplane can be pressed into service and radio communications established.

It seems to be fairly well established that such astronomical factors as variations in the eccentricity of the orbit of the earth, the precession of the equinoxes and changes in the plane of the ecliptic, which at one time were considered by glacial students as of dominant influence in glacial epochs, are subordinate to the geographical conditions, and only at times supplementary to them. The recurrence of glacial stages in the Pleistocene epoch does not correspond, even rudely, to the calculated times of greatest eccentricity of the earth's orbit, nor was there an alternation of glaciation in the northern and southern hemispheres during a precession cycle. It is known that a glacial stage required a much longer period than half of the precession cycle. Attempts to fix glacial chronology in terms of these astronomical factors are without support and entirely misleading. It is not so easy to dispose of another astronomical factor—the variation in solar radiation. So far as known, this variation is very slight, but observations cover so brief a period that it can not be assumed that the full amount of variation is known. There is a possibility that this factor has had considerable influence on the climate. Should terrestrial factors, when fully evaluated, prove inadequate to account for the conditions attending a glacial epoch, it may be necessary to fall back on solar variation. But even then it may be incapable of demonstration.

The hypothesis of continental drift, made prominent by Alfred Wegener, was given consideration as far back as 1866, when Sir John Evans presented a paper before the Royal Society "On a Possible Cause for Climatal Changes," which is published in abstract in the *Geological Magazine* for that year. Wegener's hypothesis was made the subject of discussion in a symposium participated in by fourteen scientists and published by the American Association of Petroleum Geologists in 1928 in a volume of 240 pages. Wegener contributed a brief paper of five pages, designed to meet objections to the hypothesis and to call attention to recent geodetic surveys in Greenland that seemed to him to support it. He first presented the hypothesis in 1912 in *Petermanns Mitteilungen*. In 1915 he brought out a book, "Die Entstehung der Kontinente und Ozeane." This went to a second edition in 1920 and a third in 1922 and was translated into English in 1924. It appears to have met with favorable consideration by many European students, but it has not been so well received in America.

It is not my intention to go into the discussion of the Wegener hypothesis further than to indicate its irrelevancy so far as applied to the several stages of Pleistocene glaciation. It assumes a migration of the north pole from a position west of Greenland eastward over that island into the Arctic Ocean and then northward to its present position. It interprets the glaciation to have started in the northwestern part of the North American continent and extended eastward across the continent and Greenland into Europe. Meantime Greenland became separated from Scandinavia by a westward drifting, thus giving the Atlantic a northward extension. It fails to recognize that the drift sheets, both in North America and in Europe, show a repetition of glaciation at widely separated intervals, and that successive glaciations covered essentially the same parts of each continent. So far as the last two glacial stages in North America are concerned, the Laurentide ice-sheet made a growth from east to west, or in the reverse direction from that indicated by Wegener. Were continental drift made the dominant factor it would be necessary to carry the pole westward in our Illinoian and Wisconsin glacial stages. But in view of what is clearly established in the glacial succession in Europe and America the Wegener hypothesis is purely fantastic and scarcely worthy of consideration in this connection.

The Wegener conception that the opening of the North Atlantic took place in Pleistocene time through a westward drifting of Greenland is opposed by the distribution of the Pleistocene isotherms. In last year's paper the following statement was made on this point:

> It is a matter of some significance, concerning the influence of planetary winds on the oceans in the glacial epoch, to note that the southern limit of glaciation on the European side of the Atlantic is 10° to 12° of latitude farther north than on the North American side, from which it may be inferred that the isotherms showed a difference in latitude on opposite sides of the Atlantic similar to what is found to-day. This relation shows clearly that the warm waters were driven northeastward across the north Atlantic by winds in the Pleistocene glacial stages about as they are to-day.

Wegener's claim that longitude determinations in Greenland support his view of continental drift, and show that it is still continuing, has been analyzed by Sir Charles Close, director general of the British Ordnance Survey, who finds that the differences are all within the limits of probable error and are not sufficient to prove westerly drift.[3]

Marsden Manson has brought out an elaborate hypothesis of geological climates, in a series of papers appearing in the *American Geologist* in 1899, based on the rôle of clouds as reflectors of solar radiation and of terrestrial radiation in conjunction with an assumed gradual waning of the internal heat of the earth. As a consequence of this cloud envelop it is inferred that, prior to the glacial epoch, the earth did not have the present sharply distinguished tropical, temperate and frigid zones. The conditions are most nearly realized at present in the equatorial rain belt, in which the land is maintained at the same temperatures as the neighboring ocean. While the solar radiation was greater in the low latitudes, the earth heat was not thus restricted, but was as great in high latitudes as in the equatorial region. The Permo-Carboniferous glaciation coincided to some degree with the present subtropical high-pressure belts, and it is thought that cold anticyclonic winds cooled the land most rapidly in those belts. After this the terrestrial radiation gradually diminished until the polar oceans became cold and the Quaternary glaciation followed. This glaciation was centered in the cold temperate belt of greatest precipitation, which it is thought was still overcast with a cloud belt. With progressive cooling of the oceans, the evaporation failed to supply sufficient moisture to maintain this cloud belt, and glaciation passed into the waning stage. It is still continuing in diminishing degree. The distribution of fossil plants and delicate marine organisms is such as to indicate that over long periods the present degree of climatic zoning was not in vogue. But it is a question whether cloudiness has been the controlling factor in giving this condition. The following statement concerning Manson's hypothesis is from the pen of C. E. P. Brooks, the British meteorologist:[4]

> The theory is interesting, but there are some insuperable difficulties. With warm oceans and an unbroken cloud canopy, the land surfaces, unless at a great altitude, would not be likely to freeze; the conditions are most nearly realized at present in the equatorial rain belt, in which the land is maintained at the same temperature as the neighboring oceans. "Cold anticyclonic winds" presuppose cooling by radiation. Even if under world-wide isothermal conditions the pressure distribution could remain unaltered, which is highly improbable, we must suppose either that the anticyclone would break down the cloud canopy, in which case the tropical sun would certainly prevent glaciation, or that the clouds would remain in spite of the anticyclone, in which case the descending air would not be cold. Finally, the moist conditions supposed by Marsden Manson to have prevailed during the warm periods are in direct opposition to the dry conditions demonstrated by the geological evidence set out in the Introduction.

It was pointed out by Brooks in the introduction to the volume just cited that the predominant features of the normal geological climate were warmth and dryness. "Deserts have apparently existed throughout geological time, but during most of the warm periods, and especially in the Mesozoic, they expanded greatly, extending from the sub-tropical regions far into the present temperate zones." It is probable that existing ice-sheets are responsible to a high degree for the present strong contrast in climatic zones. On this point Hobbs has expressed the following opinion:[5]

> The atmospheric circulation is given its vigor at the present time not alone through a pushing upwards of currents within the tropics as a consequence of excessive insolation within that region, but also by a pulling down by the refrigerating engines of the continental glaciers. . . .
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> During both the Permian and the Pleistocene geological periods there were vast continental glaciers in addition to those which were located over the Antarctic and Greenland. Presumably there was glaciation of these areas since there were ice-sheets in lower latitudes. The in-

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[3] *Geographical Journal*, Vol. 63, 1924, pp. 147–150.

[4] "Climate through the Ages," pp. 145–146.

[5] "Glacial Anticyclones: The Poles of the Atmospheric Circulation," pp. 168–169.

fluence of these vast domes of ice in stimulating a vigorous circulation must have been of the utmost importance, and the zonal distribution of climates should in consequence have been so much the more pronounced.

That the present zonal contrasts are connected with glacial climate is expressed in papers by leading American paleontologists which have appeared since Manson's hypothesis was brought out.[6] Of strikingly different attitude is the recent work by Köppen and Wegener, "Die Klimate der geologischen Vorzeit," Borntraeger, Berlin, 1924, which assumes that at all times in the history of the earth the same climatic contrasts have been exhibited. They also state that the changes of climate for a given region are to be interpreted as due to continental drift.[7]

A leading hypothesis based upon atmospheric conditions pertains to variations in the amount of carbon dioxide and of water vapor in the air, which was brought out by Arrhenius in 1896[8] and subsequently elaborated by Chamberlin.[8] It is suggested that the cold periods were characterized by a depletion of the carbon dioxide and warm periods were times when it was more abundant in the atmosphere. This depletion it is thought might be due to geological processes, the formation of coal and limestone being cited by Arrhenius, and the weathering of rocks made prominent by Chamberlin, as well as the agency of organisms. Variations of volcanic activity are also considered of importance. Chamberlin also developed an elaborate interpretation of the effect of the variations in carbon dioxide upon oceanic circulation, and showed that a reversal of the oceanic circulation might give rise to warm periods in high latitudes. This hypothesis has the advantage of being world-wide in its application and thus meets a need that is not met by hypotheses based chiefly upon local geographic influences. There is, however, considerable doubt expressed by meteorologists as to carbon dioxide having the influence attributed to it by Arrhenius and Chamberlin. Ångström maintains that the absorption effects attributed by Arrhenius to carbon dioxide are principally due to water vapor.[9] The water vapor content is determined by the amount of radiant energy received from the sun. Its variations are not, therefore, an ultimate cause for climatic variations. It has been pointed out by Humphreys that an increase in carbon dioxide could only affect the temperature by absorption at high levels in the atmosphere where water vapor is nearly absent, and he concludes that carbon dioxide can never have been an important factor in climatic variations.[10] A similar view is expressed by Brooks,[11] who grants that the quantity of carbon dioxide may have had considerable variation, but that these variations could not have had a great climatic effect, for the part of the terrestrial radiation taken up by carbon dioxide is almost completely absorbed by water vapor, and no increase in the amount of carbon dioxide could appreciably increase the total absorption.

It has been shown by several students that volcanic dust in the atmosphere is likely to have had a cooling effect, because of a scattering and reflection of solar radiations which it occasions. Benjamin Franklin suggested that the severe winter of 1783–84 might be due to great quantities of volcanic dust in the air. Observations on the eruption of Katmai in 1912 showed that the Katmai dust reduced the solar radiation reaching the earth by about 20 per cent., which if long maintained would lower the mean temperature of the earth about 10° F., an amount sufficient to initiate an ice-age.[12]

In view of the dissenting opinions among those who have given most attention to the effect of variations of the amount of carbon dioxide on climate it seems necessary to hold this hypothesis and that of volcanic activity as a factor in glacial climate open for further light.

One of the most significant contributions to the problem of glacial climate has been made by C. E. P. Brooks in his recent volume, "Climate through the

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[6] See David White and F. H. Knowlton, "Evidences of Paleobotany as to Geological Climate," Science, n. s., Vol. 31, 1910, p. 760. F. H. Knowlton, "Evolution of Geologic Climates," *Bull.* Geol. Soc. Am., Vol. 30, 1919, pp. 499–566. Charles Schuchert, "Climates of Geologic Time," Smithsonian Report, 1914, pp. 277–311.

[7] "In diesem Buche werden die vorzeitlichen Klimawechsel unter den Voraussetzungen der Theorie der Kontinentenverschiebung behandelt, die hier als richtig angenommen wird" (page 1).

[8] Svante Arrhenius, "On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground," *Phil. Mag.* (5), Vol. 41, 1896, pp. 237–276. T. C. Chamberlin, "An Attempt to Frame a Working Hypothesis of the Cause of Glacial Periods on an Atmospheric Basis," *Jour. Geol.*, Vol. 7, 1899, pp. 545–584, 667–685.

[9] Knut Ångström, "Über die Bedeutung des Wasserdampfes und der Kohlensäure bei der Absorption der Erdatmosphäre," *Ann. der Physik* (4), Vol. 3, 1900, p. 720. See also Hann's "Handbook of Climatology," 1903, p. 399.

[10] W. J. Humphreys, "Physics of the Air," 1920.

[11] C. E. P. Brooks, "Climate through the Ages," 1926, pp. 132–133.

[12] For discussions of this subject see: C. G. Abbot and F. E. Fowle, "Volcanoes and Climate," Ann. Astrophys. Obs. Smithsonian Inst., 1913, and Smithsonian Misc. Coll. No. 29, 1913. W. J. Humphreys, "Volcanic Dust and Other Factors in the Production of Climatic Changes, and Their Possible Relation to Ice-ages," *Jour. Franklin Inst.*, Vol. 176, 1913, pp. 131–172. Also *Jour. Wash. Acad. Sci.*, Vol. 3, 1913, pp. 365–371. C. E. P. Brooks, "Climate through the Ages," 1926, pp. 133–136. H. Arctowski, "Volcanic Dust Veils and Climatic Variations," *Annals N. Y. Acad. Sci.*, Vol. 26, 1915, pp. 149–174.

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Ages," noted above. He points out that glacial periods have occurred at times of high altitude of the land, while non-glacial periods are times of relatively low relief. He also expresses the opinion that in periods of low relief the barometric depressions, or cyclones, were less definitely developed than in periods of high relief and that storms were the thunderstorm type rather than long steady rains, such as are associated with the passage of barometric depressions. If the relief were sufficient in the district traversed by the cyclonic storms to cause precipitation as snow throughout the winter months, there would be a tendency to lower the temperature over the bordering seas and cause them to become ice-covered. When the ice cover reached a certain size the temperature on its edge would fall below the freezing-point of sea water, and it would continue to expand owing to the lowering of temperature which the ice itself introduced. By a series of mathematical calculations it is shown that a great climatic effect may follow such a covering of the polar oceans with ice, so it is merely a matter of getting the freezing process started. This might be brought about by only a slight general lowering of the earth's temperature. It is estimated that if the present average elevation of 2,500 feet were to be increased to 3,500 feet the effect on cloudiness, evaporation and area above the snow line would produce a lowering of temperature somewhere between 5° and 15° with a probability of about 9° F. While elevation is, by itself, and directly a very important factor in climate, it also causes, secondarily, changes in distribution of the land and sea, in the course of ocean currents, etc., all of which must be considered in accounting for the glacial epochs.

None of the hypotheses of purely terrestrial application appears to satisfactorily account for the great climatic fluctuations that characterized the Pleistocene glacial epochs. The glacial stages were interrupted by long intervals in which the temperature appears to have been similar to the present and the ice-sheets reduced to their present dimensions, if not more completely dissipated. It is difficult to picture geographic changes of sufficient influence to meet the conditions, though Brooks maintains that they need not be of great magnitude. He recognizes, however, that measurable climatic changes in historic time have had no basis in geographic changes and calls in extra-terrestrial influences to account for them. It is also difficult to picture changes in the amount of carbon dioxide resulting from variations in weathering processes or from volcanic eruptions of sufficient importance to meet the conditions. It is becoming increasingly apparent that some peculiar combination of several factors is necessary to account for the climatic variations exhibited in a glacial epoch. The key to this combination is yet to be discovered. It probably will be found when the factors affecting present climate are more fully understood.

As indicated above, it is probable that observational data on the existing ice sheets will aid in the interpretation of conditions attending the Pleistocene and earlier ice-sheets. At my request, Professor W. H. Hobbs has kindly outlined the lines of study that seem most desirable, as follows:

> Extension of observational data on existing continental glaciers:
>
> (1) Measurement of ice movement within the marginal portions.
> (2) Determination of depth of ice to rock base by echo method.
> (3) Determination of snow density in all sections and structure beneath by the Mt. Rose method.
> (4) Determination of time and place of snow precipitation over the ice-sheet and redistribution as drift snow.
> (5) Evidences of fusion of surface snow on the ice-sheet.
> (6) Measurements of outward radiation from the surface of the ice-sheet compared to land (bare or snow covered), to sea water and to sea ice.
> (7) Exhaustive study of the glacial anticyclone from weather stations upon and about the ice-sheet with aid of pilot and sounding balloon studies of the upper air. A station within the interior to be compared to aerological stations about, but close to, its borders. Variations in the energy of the mechanism, with corresponding variation in the dimensions of the model, should be studied (winter and summer seasonal changes).
>
> For such studies the Greenland ice-sheet offers better opportunities, because of its greater accessibility, and its simpler model. It seems to lack the interior mountain ranges, which greatly complicate the problems of the Antarctic. Aerological stations about but above its borders should tell as much.

WORLD-WIDE CORRELATIONS OF GLACIAL STAGES

While it is coming to be generally recognized that the Pleistocene glaciation was interrupted by relatively warm interglacial stages, much is yet to be done to clear up the correlation of glacial stages in the different areas of glaciation. There is still only a partial correlation of the stages in the Scandinavian field with those of the Alpine field. There is similar uncertainty as to correlations between certain drifts in the eastern and western parts of the Laurentide area of glaciation in North America. It will be well to settle the correlations within each of these continents as a preliminary to full correlations between the continents. The clearing up of these correlations between Europe and America and between the glacial stages of the northern and southern hemispheres is probably merely a matter of more detailed study of the glacial and interglacial deposits in the several fields.

LENGTH OF PLEISTOCENE GLACIAL AND INTERGLACIAL STAGES

The length of time involved in the Pleistocene glacial epoch, with included interglacial stages, has been variously estimated, though there seems to be a general consensus of opinion that at least a half million years would be required for the changes wrought since the earliest drift of Europe or of North America was laid down. Some students are inclined to double the time and put the beginning of the glacial epoch back a full million years. The main basis for estimates of the time involved has been the amount of erosion and degree of weathering that have taken place in Pleistocene time. The length of interglacial stages has been determined by a comparison of the erosion and weathering of the drift of a given glacial stage with that of the next succeeding glacial stage, allowance being made for the probable time involved in the glacial stage. This allowance, however, is a difficult matter to estimate. To properly measure a glacial stage one must determine the time involved in the advance to the culminating position, and the time involved in the development of moraines formed in the course of the waning part of the glaciation, as well as the time between successive moraines. The measurement of the varves, or annual deposits of laminated clays, introduced by De Geer in Europe and North America, and carried on widely by Antevs in the United States and Canada,[13] pertains to the time involved in the recession from one moraine to another, but not the time involved in forming a moraine. In some cases also a readvance of the ice border has buried part of the record of the recession. An entire glacial stage is likely, therefore, to require several times as long a period as that measurable by the varves. The time involved in the recession of waterfalls, such as Niagara and the Falls of St. Anthony, also covers only a small part of the waning stage, and the estimates are of chief value in giving a measure of postglacial time. From these estimates, combined with a study of the erosion of the latest drift sheet, it is calculated that it requires about 10,000 years to effect one foot of average erosion of the till. On this basis the Illinoian till, with an estimated erosion of fifteen feet, would be 150,000 years old, and the Kansan till, with an estimated erosion of fifty feet, would be 500,000 years. These estimates are perhaps of some value in giving a rough approximation as to the time involved, but should be supplanted by more refined methods of measurement. It is also important, as above noted, to work out some method for estimating the time involved in the glacial stage, and determine what proportion of the Pleistocene glacial epoch was under glacial conditions and what under the relatively warm interglacial conditions. Much is yet to be learned as to the periodicity of moraine development. It also is a matter of importance to determine why certain districts have a fuller series of moraines than neighboring ones. Our studies have shown how the ice-sheet distributed moraines but not why it did so.

RELATION OF GLACIATION TO PLEISTOCENE DIASTROPHISM

It is well established, through a study of tilted shore-lines, that the interior part of the glaciated districts in northeastern North America and in northwestern Europe have risen several hundred feet since the ice-sheet melted from them. They appear to have only partially recovered an altitude they possessed prior to the glacial epoch. The depression of the land is referred to weighting of the ice-sheet, and its recovery to relief from weighting. The presence of thick deposits of drift and of bodies of water in the lake basins is thought to have influence in preventing a complete recovery of the preglacial altitude.

The study of the shore-lines of the glacial lakes has brought out a marked lack of correspondence between the area of ice weighting and the uplifted area. It is found that the shore-lines show no tilting in the south half of the Lake Michigan basin, nor in all the Erie basin except the northeast end. Yet the ice-sheet extended far beyond the limits of these basins, and must have been thousands of feet thick in the parts unaffected by tilting. These studies and studies in other basins occupied by glacial lakes have shown that the uplift extends only a short distance beyond the Precambrian lands into the lands covered by Paleozoic formations. There appears to be a closer correspondence with the border of the Precambrian lands than with the amount of ice weighting. It appears that the ice weight was insufficient to cause such a depression in the stable areas covered with sedimentary Paleozoic formations as it was able to produce in the highly eroded Precambrian areas. There is thus an interesting problem in the relative stability of an area of great erosion and one in which sediments have accumulated. A recent paper by Bowie deals with this matter, as indicated by the following quotation:[14]

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[13] Gerard De Geer, "A Geochronology of the Last 12,000 Years," Compte Rendu du XIth Congrès Géologique International, 1910, pp. 241–253. The studies were begun by De Geer in 1879 and the results appear in papers in the Swedish language beginning in 1882. Ernst Antevs, "The Last Glaciation," Am. Geogr. Soc'y, Research Ser. No. 17, 1928, 292 pages. See also "The Recession of the Last Ice-sheet in New England," Ditto, No. 11, 1922, 120 pages. Also Canada Geol. Survey, Memoir 146, 1925, 142 pages.

> The term residual rigidity is frequently used in discussing earth problems. A material that is said to have residual rigidity is supposed to resist deformation unless the force exerted on it approaches the elastic limit of the material. In this sense the residual rigidity is equivalent to the term strength. . . .
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> It would seem probable that the strength of the crust under the sedimentary zone should have been augmented rather than decreased by the consolidated sedimentary material. . . .
>
> If there are any weak zones of the earth's crust it would seem that they underlie the regions which have undergone great erosion.

In this connection attention is directed to an erroneous map[15] prepared by a leading American glacialist, in which isobases of postglacial uplift are made to correspond to an estimated thickness of the ice-sheet in the region east of the Mississippi River, thus disregarding the results previously published of observations showing that there is no such close correspondence. No progress can be made where office speculation is substituted for or given more weight than field studies.

THE LOESS PROBLEM

Although loess is now generally recognized to be a wind deposit, it seems to have been developed under conditions related to if not dependent upon glaciation. In America its distribution along main watercourses, such as the Mississippi and Missouri valleys, and its northward limitation on the border of the glacial deposits led to an early interpretation that it was transported by streams heading in the ice-sheet. The Mississippi valley was supposed to have been down to a level low enough to give rise to fluvio-lacustrine conditions. Similar views were held by European students as to the distribution of the loess there. It soon became evident, however, that the distribution of the loess and also its fossil content favor deposition on the land, and that it was redistributed by streams down the valleys. It has also been determined that the greater part of the loess of the Mississippi basin was brought in from the semi-arid plains to the east of the Rocky Mountains, only a minor part being derived from the glacial deposits. The European and Asiatic loess deposits were also found to have been derived mainly from semi-arid districts.

The chief problem now seems to be in reference to the time of deposition of loess in relation to glacial stages. By some students loess deposition is considered a forerunner of glaciation and to some degree dependent on the conditions that produced glaciation. In places it seems to correlate with the culmination of a glacial stage. Such is the case on the early Wisconsin drift in Illinois, there being loess on the unweathered surface of the drift near its border. The waning part of a glacial stage seems to have been characterized by more humid conditions than attended the culmination, the glacial drainage being more vigorous. Such being the case it probably would be an unfavorable time for loess deposition. The molluscan fauna of the loess is very similar to the present fauna of the region and thus of a more temperate type than seems consistent with a glacial stage. This has been the main reason for giving it an interglacial position. Much, however, is to be learned as to the degree to which such a fauna would accommodate itself to climatic changes.

It is well established that there have been two if not three periods of extensive loess deposition on or near the border of the drift sheets in Europe and in North America. It will be of importance to determine whether these periods can be correlated on opposite sides of the Atlantic. Such correlations will depend upon the success achieved in correlating the drift sheets with which the loess deposits are associated.

The characteristics of loess are so different from those of other wind deposits as to raise the question of its mode of transportation. It possesses a homogeneity that is strikingly in contrast with the heterogeneous material now swept by the wind over the surface of the ground. It also is of much finer material than dune sand. It seems to be a dust that would be susceptible to long-distance transportation, and its wide distribution as well as its composition support such a history. It appears to have settled on the land which it covers and not to have been swept across it. In general, it forms a continuous sheet, allowance being made for subsequent erosion. But on the outskirts it is more patchy. Some of this patchiness may be due to subsequent sweeping by surface winds. There are strips of loess-free land alternating with loess-covered strips in such manner as to indicate much diversity in wind effect, the loess-free strips having been exposed to strong wind action from which the loess-covered strips were protected, perhaps through some difference in vegetation. Such features are well exhibited in northeastern Iowa, near the border of the Iowan drift. They may prove to be related to wind action from the Iowan ice.

RELATION OF MAN TO THE GLACIAL EPOCH

The evolution of man from lower animal forms appears to have taken place at least as far back as the early part of the Pleistocene epoch. Some students hold the opinion that the human stage was reached at a much earlier time. The skeletal remains of man imbedded in deposits of early and middle Pleistocene age in Europe, the Heidelberg, Sussex and Neanderthal remains, are of a crude type compared with those of the late Pleistocene Cro-Magnon race and suggestive of a lower order of mentality. It is a matter of importance to determine whether the inhospitable conditions of the glacial epoch stimulated mental development or had instead a brutalizing effect. Did the cruder races become exterminated under the adverse conditions attending glaciation, or instead did they develop into the superior types of men that held possession of Europe in late glacial and early postglacial time? It is a question whether the highly developed Cro-Magnon race was evolved under these adverse conditions or whether its development took place in a part of the earth where the climate was more genial and from which the race migrated into Europe as climatic conditions there became more favorable. As the race showed a strong artistic bent its origin may be determined by a wide-spread study of the works of art of primitive people.

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[14] William Bowie, "Zones of Weakness in the Earth's Crust," SCIENCE, n. s., Vol. 70, 1929, pp. 589–592.

[15] *Bull. Geol. Soc. of America*, Vol. 29, 1918, p. 202, fig. 1.

There appears to be as yet no clear evidence of human occupancy of the American continent during the glacial epoch. There have been frequent reports of the finding of chipped implements in the glacial gravel, and in the loess, but examination into the evidence by archeologists and geologists has led to the conclusion that the implements had been recently imbedded.

PROBLEMS OF GLACIAL OSCILLATIONS

Attention was called in the discussion of the duration of the glacial epoch to the lack of knowledge of the length of time involved in forming a terminal moraine. There is also a lack of knowledge as to the cause for the oscillations of the ice border so clearly shown in the waning part of a glacial stage. Many moraines show a readvance of the ice border. These readvances are separable into major and minor ones. The moraines forming the limits of the middle Wisconsin and the late Wisconsin drift illustrate the major class and mark a pronounced readvance of the ice border, also considerable shifting in the direction of the ice movement. It is on the basis of these readvances and realignments that the middle and late substages of the Wisconsin glacial stage have been recognized and named. The minor readvances amount usually to but a few miles, but like the major ones they serve to show that there was some factor in operation to intensify glacial conditions at certain times during the waning part of the glacial stage. The geographic factors are unlikely to have varied in such way as to cause this oscillation of the ice border. Nor do atmospheric factors, such as variations in the carbon dioxide or in the presence of volcanic dust, seem likely to have played an important part in intensifying glacial conditions. Seemingly it must be a climatic cause; yet the nature of the climatic change remains a problem.

ORIGIN OF DRUMLINS, KAMES AND ESKERS

Widely different interpretations of the origin of these features are found in the glacial literature, European as well as American. It is probable that some drumlins are due largely to erosion by the ice-sheet, while others are of constructional type, built up beneath the ice-sheet. Kames are likely also to have had more than one method of development. In some cases they are evidently the product of drainage in connection with an active phase of the ice border, for they show disturbed stratification, apparently due to an advance of the ice border. This has given them greater relief and incorporated till with the gravel. In other cases where composed entirely of gravel and sand in undisturbed position there may have been a stagnant or stationary position of the ice border. The long gravel ridges known as eskers, while probably formed by streams flowing within or beneath the ice-sheet, can scarcely have been formed from end to end at one time, even though the ice-sheet had become stagnant. The upper ends are probably of later development than the lower, there being a lengthening headward with the recession of the ice border. Long eskers are in many cases diversified by a plexus of ridges, occurring at short intervals. The plexus may mark the starting of a new system of drainage within the ice-sheet not far back from the ice border. Detailed study should clear up the manner in which these ridges were formed.

ORIGIN OF GUMBOTIL

In a part of the Mississippi drainage basin, chiefly in Iowa, Missouri and Illinois, the surface of the Illinoian, Kansan and pre-Kansan drifts, where exceptionally flat, is characterized by a gummy gray clay to which Kay has given the name gumbotil.[16] It is interpreted by him to be mainly the product of weathering of the surface portion of the drift, and its thickness to be a measure of the time involved in its development. It has a thickness of two to five feet on the Illinoian till where best developed and a greater thickness on the Kansan and pre-Kansan tills. Its greatest thickness is on the flat divides on the Kansan drift of southern Iowa and northern Missouri, where it commonly is about eight feet and occasionally twelve feet or more. It is singularly lacking in coarse pebbles, even in places where the underlying drift carries coarse pebbles of quartzite which would be likely to withstand dissolution for a much longer period than is embraced in the Pleistocene glacial epoch. There are small quartz pebbles in the deposit at all levels, but large pebbles are only found close to the underlying till. The thickness of the gumbotil decreases in passing northward, but it has been found on the Kansan till in northeastern Iowa beneath the Iowan till. It is, however, not so thick there as it is beneath the Illinoian till in southeastern Iowa, or beneath the loess in other parts of southern Iowa and in northern Missouri. The gumbotil on the Illinoian drift is thickest at the western edge of the drift, in southeastern Iowa and western Illinois. It is inconspicuous or wanting in eastern Illinois, Indiana and Ohio. It has not been noted on the Illinoian drift of Pennsylvania and New Jersey. Nor has it been observed on the Jerseyan drift in those states.

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[16] G. F. Kay, SCIENCE, n. s., Vol. 44, 1916, pp. 637–638.

The restriction in distribution and the variation in thickness on a given drift seem to indicate that there is some factor other than mere lapse of time that governs the development of gumbotil. The restriction of coarse pebbles to the base of the deposit raises the suspicion that it may be only to a moderate degree the result of weathering of the till. The small pebbles in its upper part may in that case have been brought up into it by crayfish, as is the case in poorly drained parts of the loess. There is perhaps significance in the fact that the gumbotil shows variations in thickness that correspond in some degree to variations in the thickness of the loess. The thickness of the gumbotil thus may be found to depend partly upon wind deposition. If the wind brought in material at a very slow rate it might become weathered to a gummy condition, as the fine material in the till is supposed to have been. The deposition of the loess was probably at a sufficiently rapid rate to escape conversion into such a condition. Whatever its origin the gumbotil appears to have required a period of considerable length for its development, for its material shows throughout an advanced degree of weathering.

Kay has expressed the opinion that the gumbotil was formed under conditions of low altitude unfavorable for the erosion of the drift and has assumed that its development was nearly completed prior to a hypothetical uplift of the land that gave favorable conditions for erosion.[17] On this supposition a long period must be given for gumbotil development and another long period for the erosion of the drift, as indicated in the following quotation:

> After the gumbo plain had been developed by weathering processes on the Kansan drift plain, diastrophic movements seem to have occurred, the plain having been elevated to such an extent that erosion became effective and valleys began to be cut into the gumbo plain. Erosion of the gumbo plain progressed to such an extent that some valleys were cut to a depth of more than 150 feet before grade was reached and a mature topography was developed. There are now only remnants of the original gumbo plain, the most conspicuous of these being flat, poorly drained areas, known as tabular divides.

It is a matter of considerable importance in estimating the time since the Kansan stage of glaciation to determine whether conditions favorable for the erosion its drift displays were operative as soon as the ice uncovered it or only came into operation after a long period as Kay has suggested. It seems unnecessary for the gumbotil to have been completely developed before erosion began if the land had an attitude favorable for erosion from the beginning. The gumbotil, it would seem, might have been developing on flat areas throughout the time in which erosion was active, until prevented from further development by the deposition of a sheet of loess over it. The loess deposition is known to have taken place after the Kansan drift had become greatly eroded. So far as I am aware, Kay has produced no evidence that would clearly establish the uplift of the Kansan drift area which he has postulated, but has merely made the assertion that diastrophic movements seem to him necessary to succeed gumbotil development. This matter concerns Illinoian as well as Kansan gumbotil development and naturally leads to the consideration of drainage conditions in the Mississippi basin in the Kansan and Illinoian stages of glaciation.

CONDITIONS OF GLACIAL DRAINAGE IN THE MISSISSIPPI BASIN

So far as can be determined after allowing for the great amount of erosion that the Kansan drift and its outwash have experienced, there was very little material carried from the border of the Kansan ice-sheet into the valleys that led away from it. There is a moderate amount of gravel in the Mississippi valley at Hannibal, Missouri, where the Kansan drift border passes across the valley from Illinois into Missouri, and also at a few points below, which appear to indicate that conditions were favorable for the discharge of water down the valley while the ice was melting. The Missouri valley in Missouri was largely outside the Kansan drift border, but the drift extends south of the valley in Saline County, and there considerable sand and gravel are present along the edge of the drift and interbedded with the till. Below there, in Cooper County, the valley was filled sufficiently to cause a temporary flow of the Missouri through a low passage only two to three miles south of the river. These features combine to show that the ice-sheet was not terminating in ponded water in either of these main valleys. There is, however, such general scarcity of sand and gravel in the Kansan drift in its entire area of exposure, in Missouri, Kansas, Nebraska, Iowa, Wisconsin, Minnesota and South Dakota, as to indicate that there was very weak flow of water from its border as it was melting back across these states. So far as known also no morainic ridges were formed in the course of its retreat. It becomes, therefore, a matter of interest to determine the cause for these conditions. The lack of moraines suggests a steady recession of the ice border, without such oscillations as characterized the Wisconsin stage. The lack of outwash, if not due to poor drainage conditions, may perhaps be accounted for by the slow rate of melting of the ice.

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[17] *Bull. Geol. Soc. Am.*, Vol. 27, 1916, pp. 115–117.

The Illinoian drift also is remarkably free from outwash over a considerable part of its area of exposure, from southwestern Ohio westward into southeastern Iowa. But along its border in southeastern Iowa there is a well-defined channel opened by the temporary Mississippi River at the time its present valley between Clinton and Ft. Madison was occupied by the ice-sheet. There is a deposit of sand and gravel of probable Illinoian age in the Mississippi valley below Keokuk. But none has been noted on the border of the Illinoian drift in southeastern Iowa or in Illinois. The temporary Mississippi channel is nearly free from sand and gravel, though it appears to have had free discharge. This gives rise to the question whether the temporary Mississippi River was mainly carrying the drainage from the outlying land and receiving very little water from the melting Illinoian ice-sheet. In that case the rate of melting of the ice was probably very slow. The Illinoian ice-sheet formed several definite morainic ridges as it was melting back across Illinois and has a definite morainic ridge along most of the drift border in Illinois, Iowa and southern Wisconsin. It also carries gravel in the form of kames and eskers over much of its area of exposure in these states and farther east. There is a change from very scanty outwash to a conspicuous outwash at the Scioto valley in southern Ohio, and this condition is maintained from there eastward to the Allegheny Mountains and is also found on the Susquehanna valley in eastern Pennsylvania. Inasmuch as the Ohio valley was covered for a long distance by the Illinoian ice-sheet at its culmination, in the part below the mouth of the Scioto River, it is probable that the vigorous Illinoian drainage on the Scioto and streams farther east came after the ice-sheet had vacated the Ohio valley.

The Iowan drift is characterized by very scanty outwash in northeastern and northwestern Iowa, but has conspicuous outwash into Big Sioux valley and several of its eastern tributaries in South Dakota. The scantiness of outwash in Iowa seems not to have been due to obstructed drainage. It may prove to be due to the slow rate of melting of the ice.

Outwash is very scanty in connection with the moraines of the early Wisconsin drift in Illinois, Indiana and Ohio, but is conspicuous in connection with the moraines of the middle and late Wisconsin drift in these states. The difference is not attributable to less favorable conditions for the discharge of water from the early Wisconsin moraines. In this case, as in the older drifts, there may have been too slow a rate of melting to give vigorous flow from the ice border. The early Wisconsin moraines carry a thin deposit of silt loam of loess-like character, and this, as already indicated, appears to have been deposited before the surface of the moraines had suffered perceptible weathering or erosion. Perhaps this silt loam was carried up on the edge of the ice-sheet by wind blowing from the loess-covered district outside, in which case it would tend to protect the ice from the sun and lower the rate of melting. It is to be expected also that the rate of melting of the ice-sheet when at its culminating position would be slower than in the waning stage, when warmer conditions had set in.

THE IOWAN DRIFT PROBLEM

The Iowan, or third drift of the region west of the Driftless Area of the upper Mississippi valley, is of such a problematical character that the students who have examined it have been unable thus far to come to an agreement as to its place and rank in the glacial series. It is a very thin and somewhat patchy deposit, whose eastern limits in Iowa and Minnesota are so difficult to define that there is no agreement as to its extent. The western limits, in northwestern Iowa and northward into South Dakota, are better defined, being marked in places by a weak morainic ridge. The western part was interpreted by Macbride, and also by Leverett and Sardeson, to be referable to the Wisconsin stage of glaciation. But later studies by Leverett and by Kay and Carman have led them to consider it a probable correlative of the Iowan drift of eastern Iowa. This interpretation is based upon the degree of weathering that the drift exhibits, and the presence of a loess deposit on a considerable part of its surface. It is also very thin and patchy like the eastern area of Iowan drift. In both areas it overlies a greatly eroded Kansan drift, and is accordingly interpreted to be much younger than that drift. In constitution it is very similar to the Kansan drift, and probably was largely derived from it.

The principal question now in dispute is the relation of the Iowan to the Illinoian drift. Chamberlin and Leverett in recent years have referred it tentatively to the same glacial stage as the Illinoian drift. But Kay and his associates on the Iowa Geological Survey and Alden of the U. S. Geological Survey hold to an early idea that it is the product of a distinct glacial stage standing between the Illinoian and the Wisconsin. They grant, however, that there does not seem to be any equivalent of the Iowan drift in the district east of the Mississippi valley. They thus restrict the Illinoian drift to the Labrador part of the Laurentide field of glaciation, and the Iowan to the Keewatin part, which seems a very doubtful and unnatural restriction.

The reference of the Iowan drift to a later glacial stage than the Illinoian is based by these students on the lack of a gumbotil deposit on its surface, such as is found on neighboring parts of the Illinoian drift. They also maintain that the erosion and weathering and especially the leaching of lime is less on the Iowan drift. Recently Kay has announced the presence of a loess deposit on the Illinoian drift that seems to him to correlate with a loess that underlies the Iowan drift. The absence of gumbotil on the Iowan drift seems to be due to a lack of favorable conditions for its development rather than to a lack of time. It is hoped that further field study may clear up the remaining points of difference.

CONCLUSION

From what has been outlined it will be seen that there are problems of various kinds awaiting solution. These problems call for training in various lines. There will be work for students of various degrees of ability. But, as remarked by one of my associates, it will require native ability, thorough training and a steady scientific aim to clarify the main problems of glacial geology.

A NEW SCIENCE[1]

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The most ancient art—and still an art—emerges into the most modern science, one that began to develop with the "Machine Age" and never will be completed.

> We need science in education, and much more of it than we now have, not primarily to train technicians for the industries which demand them, though that may be important, but much more to give everybody a little glimpse of the scientific mode of approach to life's problems.—R. A. MILLIKAN.

"NECESSITY—thou best of peacemakers, as well as surest prompter of invention," said Sir Walter Scott. Necessity has often been described as the mother of invention, but there have been other parents such as desire and even accident. Whatever the economic urge behind invention may have been, it is clear that to-day science is the father of both discovery and invention so far as method is concerned. What have been the forces which have propelled individuals toward new goals? The search for the beginning of an idea usually leads far back of the date of the invention, and it is difficult to place a historical finger on the individual who originated an idea. National urges and movements are much easier to trace and in the long run are as important in measuring the causes of and steps in discovery and the resulting influences on the social organism.

Just what was the motive force five thousand years ago in the Nile Valley? A desire for a form of immortality led to the construction of the tombs and pyramids of Egypt. The temples of Thebes, Amenra, Edfu, Luxor, Memphis, Baalbeck and others were erected to perpetuate a cult. They represent a national skill, but not a national culture, as the erection of such monuments was by the decree of a despot and at the expense of thousands of slaves.

Greece was a democracy, and the national search for beauty gave us the Parthenon and the attendant philosophy of Plato. Not less impressive were certain scientific gifts contributed by Greek culture of which much less is said.

Religious zeal also gave us the Gothic period, which was the first architectural style to emphasize the vertical line. The cathedrals of Bourges, Chartres, Amiens, Rheims, Notre Dame, Salisbury, Wells, York, Lincoln, Cologne and Milan represent a wide-flung culture and a reborn skill.

Whatever have been the incentives to progress and whatever scale of intelligence may have been reached, there have been limitations to the skill or productivity of nations, and the most obvious has been the tools which they used. The implements of primitive man were the product of hunger, fear, love and his environment, but the later national advances were limited by the tools available, and tools have been a product of science as the latter has fabricated new materials and discovered new principles. The greater the advancement of a nation, the more it is dependent on the contributions of science.

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[1] Address of the retiring vice-president of Section M—Engineering, American Association for the Advancement of Science, Des Moines, December, 1929.

The tools of the Egyptian period from 4000 to 1000 B. C. were of bronze and included straight and circular saws, solid and core drills, chisels, hammers and axes for dressing timber and stone. Their skill as workers in stone was limited by the materials and tools which they possessed. The Greeks attained even finer expression with tools of the same materials, and their craftsmanship as designers and sculptors was acquired and perfected in a comparatively short period of national history.

Invention could offer very little improvement in tools and skill until long after the Christian era began. Roman ruins reveal bronze as the metal most frequently used, and the best Roman art was transplanted from Greece.

Roman aqueducts are monuments to the ability of early engineers who worked with simple tools. Aqueducts and roads were among the earliest utilities constructed for public benefit. Egypt had its irrigation canals and pyramids; Greece had supplied water to Athens by gravity, but Rome was conspicuous for its early engineering works which were constructed in the face of great obstacles. Such knowledge as there was of column, beam and arch was empirical—the product of experience rather than of science. The first circular arch of which we have knowledge is Egyptian and dates from about 1550 B. C. It was formed of four courses of brick totaling four feet in thickness and was eleven feet in span. The dome belongs to a later period, about 440 B. C., and was probably of Etruscan origin.

For a thousand years, skill remained at or below the Greek level. Few inventions were made, and inventions are ideas at work.

Let us trace a few of the most impressive inventions and discoveries of a scientific character and their influence on knowledge and skill in the use of it.

Astronomy began with the earliest civilization. The Egyptians, during their most productive period, had a calendar and a system of simple surveying, and they located the axes of some of their temples by stellar or solar observations.

But the Greeks left much more to admire. Pythagoras pronounced the earth round. Anaxagoras first stated the theory that the sun, moon, stars and meteors were of a common substance from a common source—"one of the most marvelous feats of human intelligence," says Henry Smith Williams in his "History of Science."

Ptolemy was a transplanted Greek who first discovered the solar system as such, though in error in locating the earth as the center. Little was possible in geography or navigation until the truth about the solar system was discovered.

Archimedes, the inventor of the screw pump, may be called the father of the science of mechanics. Previous to his time (the third century B. C.) water was raised by buckets operated by hand for irrigation and domestic use. His was an important contribution as it involved an analysis of the screw. He first formulated the principle of buoyancy and determined the relation between a sphere and a circumscribing cylinder by experiment and analysis.

There followed over ten centuries fallow in the field of mechanics. Galileo then corrected the theories of Aristotle on falling bodies, announced the principle of forces in equilibrium, of inertia, studied the telescope, the earth's motion and the pendulum. Newton followed immediately with his well-known principles.

The birth of the science of mechanics dates from Archimedes, but its adolescence lasted over fifteen hundred years. Its renaissance was accompanied by a galaxy of contributors, chief of whom were Kepler, Huyghens, Descartes, Maxwell, Rankine.

The study of anatomy, no doubt, began in prehistoric times, but it is not until the time of Pythagoras and Aesculapius that the science began to emerge. The function of heart, veins, arteries and the brain were contemplated, and "the four elements, fire, water, earth and air, were made the basis of all organisms," then little progress was made for two thousand years, until Harvey discovered the circulation of the blood, oxygen was studied by Priestley about 1774 and, beginning with Pasteur in the last century, came the rise of biology. The Greeks considered the atom, but this field of science was closed to them and to their successors until the microscope was produced.

Aristarchus and Hipparchus made real studies of the size of the sun, moon and earth, but their apparatus was inaccurate. Hipparchus is credited with the first pronouncement of the precession of the equinoxes, although the fact of such a movement must have been known to the Egyptians. Ptolemy followed Hipparchus but failed to accept the sun as the center of our solar system.

There was experimental knowledge at an early date of the effect of heat on air, but Hero, of Alexandria, was the first, so far as we have record, to use heat to do work. His inventions were toys rather than devices for relieving men of labor, and to them perhaps too much importance has been attached. Nevertheless, tremendous significance must be assigned to the Greek contributions to early science.

The Romans contributed to geography, medicine and law but left no such impress on science as the Greeks.

During the ten centuries following the opening of the Christian era a few contributions to science were made by Arabic and Roman scholars, but the period is comparatively sterile. Science was throttled; skill was limited. The rotundity of the earth was not accepted and a true concept of the solar system was not vigorously sponsored, though it had been suggested by both Greek and Alexandrian searchers.

In the thirteenth century, advances were made in medicine. Universities were founded in Italy, France, England and Germany. Roger Bacon reviewed the learning of certain Arabians and pronounced in favor of a scientific search for truth.

It was not until the fifteenth century that master minds emerged from the dark ages. Columbus, Leonardo da Vinci and Copernicus were born in this period. Columbus proved what Ptolemy and his followers had pronounced, that the earth was round. Leonardo added to the proof that the earth moved and the sun did not. He experimented with steam much as Hero had done, but made no material advance. He observed many facts of nature and formulated a few principles which marked an advance in the field of geology and optics. His accomplishments as an engineer, military genius and artist are much more impressive than his contributions to science.

Copernicus was a German who studied in Vienna and Rome. He taught mathematics and for thirty or more years considered the Ptolemaic theory. He did not publish his famous book addressed to the pope until about the time of his death.

Tycho Brahe contributed to the advance of astronomy but rejected a part of the Copernican theory.

Kepler, a sixteenth century observer, successfully defended the theory of Copernicus and announced his three laws concerning the variation in speed and in the distance of the planets from the sun as they traveled their elliptic orbits.

At about this same time, the first systematic studies of magnetism were made by William Gilbert in England. Galileo believed in him, and later Priestley called Gilbert the father of modern electricity. He coined the phrases, "north and south poles," "electric force" and "electric attraction." He distinguished between magnetism and electricity and made numerous experiments.

Alchemy and astrology had existed from the beginning, handmaids of ignorance, superstition and evil. They throve until about the time of Elizabeth, when advances in the search for facts began to cast grave doubts on them. Progress in anatomy was made by a considerable number of investigators leading up to Harvey, who first understood the blood circulation and the action of the heart. Closely following came the discovery of bacteria by Leeuwenhoek, in 1683.

These two discoveries laid the foundation for a science of medicine which, however, grew very slowly. The scientific method was applied by a few, such as Descartes and Leibnitz.

Boyle, Hook, Huygens, all added to the refinement of physics. Newton formulated his laws of motion and of gravitation, studied the spectrum of light, the nature of color, refraction and reflection.

A very large number of investigators followed Gilbert and contributed something to our knowledge of static electricity. It was, in fact, applied in medicine as early as 1743. William Watson, of England, appears to have described his experiments, and his descriptions were read by Benjamin Franklin. He and his coworkers began a long series of very productive experiments, first with the Leyden jar, from which he constructed a battery. Several had suspected the identity of electricity and lightning, but Franklin was the first to prove it.

A scientific basis for the development of an electrical science was laid by Faraday, Henry and others in the next half century, and close on its heels came one of the most spectacular changes in industry and society.

James Watt condensed steam in a more efficient way and his successors improved the art. Rankine, Carnot, Joule and others developed the science of heat energy and showed that heat *is* energy. Without this science our present social organization would be impossible.

May I emphasize that in nearly all fields the development of a science has been followed quickly by applications which have had great significance?

We have developed the science of the infinitesimal, of the infinite and of nearly every phenomenon in the earth beneath, the waters thereof and the heavens above so far as they relate to matter, force and motion. The changes resulting from this new knowledge have transformed the environment of man though they may have influenced his character but little. We find ourselves in the midst of an industrial civilization which has removed physical limitations and reduced manual burdens. This age of men and machines is hailed as a savior and condemned as a destroyer. Obviously, the machine itself is guiltless. If it serves, then the designer, inventor, manager are to be commended. If the machine is a curse, then it seems that the person or persons responsible for the abuse are guilty. The machine can do no wrong, can break no laws. Laws may abolish certain tools or machines because they are to be used for evil purposes just as men are removed from society because they are dangerous.

The science which has developed the materials and instruments of this age of power has been followed by applications which were impossible before. The art has followed the science rapidly. The skill of men has been equal to the materials and tools provided.

Science has developed a law of action for nearly every force known to man, but there has been no accepted science of man-power, no science to serve as a guide to the management of men. Numerous principles have been proposed commencing with the Biblical injunction to "Do unto your neighbor as ye would that he should do unto you." The psychologist has studied intelligence, nerve action, inhibitions and complexes. The economist has studied trade, wealth and cycles of various kinds. The social scientist has dealt with masses, movements and legal restraints. None of these has attempted to develop either a theory or a practice of industrial operations, *i.e.*, a science of management.

The earliest important contribution to a science of directing and using human energy was by Frederick Taylor, who applied the scientific method of measurement to tasks and approached the problem of wages and incentives in the same manner. Gantt, Barth, Emerson, the Gilbreths and many others have contributed to this scientific achievement of the twentieth century. It has been summarized and formulated by Mr. L. P. Alford in a paper presented to the American Society of Mechanical Engineers in 1926, in which principles are laid down for handling materials, the product and men. The laws of leadership are capable of broad application even to colleges and universities. The law of responsibility, the law of exceptions, the law of task and wage incentives, the law of productivity, the law of acquiring skill are fundamental precepts, the recognition of which lays a firmer foundation on which to build administrative skill.

In engineering education recently nothing has attracted more attention than instruction in the field of human relations and industrial proficiency. The personality of the student as well as scholarship is being considered, and the approach to industry is becoming rationalized. Sentimentalism is being replaced by facts and preparation. The induction process begins in college and continues well into industry. Systematic study is replacing a *laissez faire* attitude, and something of the scientific approach is being made. Enlightened management is no less an art but more of a science, and so far as it is a science we may not ignore it entirely in our engineering instruction. The methods employed may differ widely but the purpose is to make the young man more familiar with some of the elementary principles.

OBITUARY

DEXTER DWIGHT MAYNE

Dexter Dwight Mayne, for twenty-six years principal of the School of Agriculture, University Farm, St. Paul, Minnesota, died at Gulfport, Mississippi, on Saturday, December 14, and was buried at Platteville, Wisconsin, on Friday, December 20.

Professor Mayne was born at Beetown, Wisconsin, May 14, 1863, the son of Nicholas and Mary (Treloar) Mayne. He was graduated from the State Normal School at Platteville in 1883. He was principal of schools at Fennimore, Wis., from 1883 to 1884; Elkhorn, 1884 to 1889; Fort Atkinson, 1889 to 1893; superintendent and principal of schools, Janesville, Wisconsin, 1893 to 1901, and superintendent of schools, Ishpeming, Michigan, 1901 to 1902. From the last-named place he went to the School of Agriculture of the University of Minnesota, a technical school giving a course of three years, of six months each year, and open to pupils who had had only grammar-school preparation, on the same campus but separate from the College of Agriculture of the University of Minnesota. In this position he continued until his death.

Under Professor Mayne the School of Agriculture of the University of Minnesota had a remarkable growth, the attendance at one time approaching or exceeding one thousand. Its success was so marked that it attracted attention throughout the country and led to the establishment of two similar schools, one at Crookston and one at Morris, Minnesota, within a few years after Professor Mayne assumed the headship of the school at University Farm. Three years ago a third school of the kind was opened at Grand Rapids. The establishment of these outlying schools, with the introduction of agriculture into the curriculums of high schools of Minnesota, led to a falling off in the attendance at the school at University Farm, but the school has continued throughout to attract large numbers of students interested in training themselves for leadership in farm and rural home life.

Professor Mayne was a man of alert mind and prompt and sure decisions, of persuasive friendliness and of resolute will. He was quick to decide and quick to act, and persistent in following through any project undertaken for the development of his students. He gave much time to intimate personal contact with the young men and young women under him, and his students were swift to respond. Their confidence, once won, never weakened. He had the extraordinary gift of imparting inspiration and awakening ambition, and throughout the central northwest to-day are great numbers of young men and young women, graduates or former students of the school, in positions of leadership and influence. He was also held in highest regard by his colleagues in the university department of agriculture.

W. P. K.

RECENT DEATHS

DR. ASAPH HALL, of the U. S. Naval Observatory, who retired from a professorship of mathematics in the U. S. Navy on June 30 of last year, died on January 12 in his seventy-first year.

WILLIAM ALLEN ORTON, director of the Tropical Plant Research Foundation, died on January 7 at the age of fifty-two years. Dr Orton ended twenty-five years' service as plant pathologist of the Department of Agriculture in 1924.

DR. H. J. PACK, entomologist of the staff of the Utah Agricultural Experiment Station, died on January 5.

WILLIAM EDWARD MEEHAN, designer and for seventeen years director of the municipal aquarium in Fairmount Park, Philadelphia, died on January 2 at the age of seventy-six years. Mr. Meehan had been an associate editor of *The Public Ledger* for fifteen years and was the botanist of the Peary Relief Expedition to North Greenland in 1892.

HENRY J. COX, aged sixty-six, meteorologist of the U. S. Weather Bureau in Chicago, died on January 7.

DR. JOHN ROBERT BENTON, dean of the college of engineering in the University of Florida, has died at the age of fifty-three years.

COLONEL ROBERT A. MARR, inventor and civil engineer, died on January 2 at the age of seventy-three years. Colonel Marr was head of the department of civil engineering of the Virginia Military Institute and later became dean of engineering at the Virginia Polytechnic Institute.

PROFESSOR PHILIP JACOB WHITE, professor of zoology at the University College of North Wales, Bangor, died on December 26 at the age of sixty-seven years. He was director of the Puffin Island Biological Station. He reached the age limit for retirement two years ago, but was granted an extension till the close of the present session.

THE following resolution was adopted at the mid-winter meeting of the Western Society of Naturalists:

> The members of the Western Society of Naturalists have learned of the tragic disaster to the ship *Carnegie* which interrupted important researches in terrestrial magnetism, meteorology and oceanography and caused the untimely death of Captain J. P. Ault, a man unique in the history of science, combining the highest scientific attainments with unusual qualities of leadership; be it, therefore,
>
> *Resolved,* That the Western Society of Naturalists at their mid-winter meeting at the Hopkins Marine Station, at Pacific Grove, extend their sincere sympathy to Captain Ault's family and to the Carnegie Institution of Washington; and, be it further
>
> *Resolved,* That copies of this resolution be sent to Mrs. Ault, to the Carnegie Institution of Washington and to SCIENCE.

G. F. MCEWEN,
T. G. THOMPSON,
E. G. MOBERG, *chairman*

SCIENTIFIC EVENTS

MUSEUM AND LABORATORY FOR THE STUDY OF INDIAN LIFE

PLANS for the construction of a museum and laboratory for the study of American Indian Life in the heart of the cliff-dwelling area of New Mexico have been completed with the selection as architect of John Gaw Meem, of Santa Fé, member of the American Institute of Architects, according to an announcement by the Board of Trustees of the Laboratory of Anthropology at Santa Fé. The first unit of the proposed group of buildings will be built in the early spring with funds granted by John D. Rockefeller, Jr.

Mr. Rockefeller has given $200,000 for the erection and equipment of the first of the ten units planned, and will also contribute the income of a fund of $300,000 toward the budget of the laboratory for five years. Additional contributions, and possibly a permanent endowment, are expected from the same source if the laboratory proves its value as a lasting operative institution.

When completed the project will provide research laboratories, museum exhibitions, libraries, lecture halls and adequate facilities for graduate instruction in archeology as well as public education in the history of America's native races. Standing in the center of the cliff-dwelling area, and near the largest Pueblo Indian villages, the laboratories will enable research workers to study New Mexico's valuable historic relics without their removal from the state.

The buildings will be erected on a fifty-acre plot on the outskirts of Santa Fé. Mr. Meem has designed the plans for the group in what is termed the "Santa Fé" style of architecture. The first unit will cover a ground area of about 8,000 square feet and will contain on one floor administrative offices, exhibition halls, laboratories, studies, an assembly hall and lounge, and a library.

"The unit which will be built early this spring," the announcement of the trustees says, "is to be the first of a series of buildings which, it is hoped, will ultimately bring together records and exhibits of all the important aspects of research work in the Southwest. We intend to coordinate the studies of American Indian life from the earliest times to the present, to facilitate research work and to help spread a knowledge and understanding of America's archeological past."

A field training school will be maintained for the benefit of graduate students and residence scholarships made available for the assistance of advanced students.

Other units to be added to the central structure are the Navajo Building, to be constructed immediately, an Ethnological Laboratory, four laboratories for allied branches of research, an Administration Building, living quarters for the staff, a residence for the Director, a garage and "corrals," a central heating and power plant, and experimental gardens.

The Laboratory of Anthropology was incorporated in New York in 1927 and has been engaged in attaining its project since then. Its trustees include representatives of leading universities, museums and scientific institutions throughout the country. They are:

R. B. Dixon, Harvard University; Kenneth M. Chapman, Indian Arts Fund; Ralph Linton, Field Museum of Natural History; J. A. B. Scherer, of the Southwest Museum, Los Angeles; Earl H. Morris, University of Colorado; G. G. MacCurdy, Yale University Prehistoric School; N. C. Nelson, American Museum of Natural History, and F. G. Speck, University of Pennsylvania; A. V. Kidder, Phillips Academy, Andover, Mass.; Franz Boas, Columbia University; A. L. Kroeber, University of California; Byron Cummings, University of Arizona; E. L. Hewett, Museum of New Mexico; C. E. Guthe, University of Michigan; N. M. Judd, Smithsonian Institution; Sylvanus Morley, Carnegie Institution of Washington, and E. A. Hooton, Harvard University; F. W. Hodge, Museum of the American Indian; Clark Wissler, Museum of Natural History; H. C. Bumpus, American Association of Museums; F. C. Cole, University of Chicago; R. V. D. Magoffin, Archeological Institute of America; Jesse L. Nusbaum, Mesa Verde National Park, and Amelia Elizabeth White, Eastern Association on Indian Affairs; Elsie Clews Parsons, Southwest Society; Margaret McKittrick, New Mexico Association on Indian Affairs; Frederick Harvey, Fred Harvey Company; W. H. Simpson, Santa Fé Railroad; J. F. Zimmerman, University of New Mexico; Leslie Spier, University of Washington; Bronson M. Cutting, United States Senator from New Mexico.

Those who signed the original articles of incorporation were Kenneth M. Chapman, R. B. Dixon, F. W. Hodge, Neil M. Judd, A. V. Kidder, Sylvanus Griswold Morley, and Clark Wissler. The executive committee now includes A. V. Kidder, chairman; Kenneth M. Chapman, secretary; R. B. Dixon, F. C. Cole, Amelia Elizabeth White, and J. F. Zimmerman.

STORROW FELLOWSHIPS IN GEOLOGY AND GEOGRAPHY

IN view of the scarcity of fellowships in geology and geography as compared with other physical and chemical sciences, those interested in the former subjects will welcome the announcement by the chairman, Dr. Arthur Keith, of the division of geology and geography of the National Research Council, that through the generosity of Mrs. J. J. Storrow, of Boston, several liberally planned fellowships in geology and geography will be granted under that division of the council. The only condition imposed by the donor is the desirable provision that she will have opportunity to establish personal acquaintance with the fellows.

The purpose of the fellowships is to enable young men of unusual ability and aptitude for the work to embark in the field of research in any branch of geology or geography. They are without restriction as to institution, though the committee may designate the institution to which a given fellow shall go for given work. No advanced degree will be required, though it is presumed that the candidates will have had training equivalent, at least, to the bachelor's degree. Further, the fellow need not be a candidate for an advanced degree, the view of the committee being that training for research and the launching of gifted young men in successful research are more important than the routine attainment of a degree. The committee desires especially to aid several men of outstanding qualities who lack funds for the final training needed to carry them over under the best guidance into well-founded research careers. The awards will not be confined to students but may go to young men out of college who by means of a fellowship may be enabled either to enter on a research career for which their preparation is already nearly complete, or to secure further training in a line of research which they have already entered with evident promise of making good.

The annual stipend is $1,200 or more, depending on the conditions obtaining in the particular case. Commitments will be for one year only. Applications will be welcomed. Much care will be taken to determine the qualifications and particularly the ability of the candidate to make the best use of the opportunities to be offered. The applicant should state age, training, work done, objectives and plans, giving references. Correspondence should be addressed to Chairman, Committee on Fellowships, Division of Geology and Geography, National Research Council, B & 21st Streets, Washington, D. C., and should be in the hands of the committee before April 5.

ECOLOGICAL MONOGRAPHS

ARRANGEMENTS have been completed between The Ecological Society of America and Duke University for the establishment of a new quarterly journal to be known as *Ecological Monographs* which will begin publication in January, 1931. The Ecological Society becomes responsible for appointing all but one of the editorial board, the other member will represent Duke University, and for the editorial policy of the new series, while Duke University assumes charge of publication and of financial aspects.

At the Des Moines meetings, the society elected:

A. S. Pearse, Duke University, Editor.
Barrington Moore, Editor of *Ecology*, ex-officio associate editor of *Ecological Monographs*.

The other associate editors elected are:

H. A. Gleason, Brooklyn Botanical Garden
J. E. Weaver, University of Nebraska
E. N. Transeau, Ohio State University
R. N. Chapman, University of Minnesota
R. E. Coker, University of North Carolina
Chancey Juday, University of Wisconsin

In view of Professor Pearse's absence in Japan until the opening of the academic year of 1930–31 papers intended for submission to the new journal should be sent forward to any one of the above editorial board or they may be sent forward to the undersigned, who as chairman of the society's committee on the publication of longer papers is still actively interested in this project.

Present plans call for the issuing of *Ecological Monographs* as a quarterly journal devoted to the publication of researches in longer papers of ecological interest from the entire field of biological science. It proposes to undertake the publication of papers from 25 to 100 printed pages in length which are too long for *Ecology*, the other journal established by the society. The board of editors will be glad to consider thoroughly scientific manuscripts which deal with any aspect of ecological investigation, including such practical fields as—horticulture, economic entomology and forestry, but will not include technical papers which deal solely with economic problems.

The subscription price will be six dollars per annual volume of about 500 pp. Sustaining members of the Ecological Society will receive both *Ecological Monographs* and *Ecology* without increase in dues, just as all regular members now receive the latter journal.

W. C. ALLEE

THE UNIVERSITY OF CHICAGO

CANADIAN PHYTOPATHOLOGICAL SOCIETY

THE first meeting of the Canadian Phytopathological Society was held in Ottawa on December 19 and 20, 1929. In addition to the presentation of some twenty papers on various phases of plant pathology, organization was completed and the following officers elected for the year 1930:

President—H. T. Güssow, Dominion botanist, Department of Agriculture, Ottawa, Canada.
Vice-president—W. P. Fraser, professor of biology, University of Saskatchewan, Saskatoon, Sask.
Secretary-Treasurer—T. G. Major, tobacco division, department of Agriculture, Ottawa, Canada.
Councillors—D. L. Bailey, professor of plant pathology, University of Toronto; J. G. Coulson, professor of plant pathology, McGill University.

The new society is an outgrowth of the former Canadian Division of the American Phytopathological Society formed in 1919 and which has now been dissolved. The society will be affiliated with the Canadian Society of Technical Agriculturists. Publication of the "Proceedings" will be commenced immediately, and arrangements are being completed for the publication of other papers in "Scientific Agriculture" until such time as the society is in a position to publish its own journal.

T. G. Major, secretary-treasurer, writes that the new society extends greetings to the phytopathologists of the United States, and bespeaks their cooperation.

OFFICERS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE proceedings of the Des Moines meeting of the American Association for the Advancement of Science and the associated societies will be reported by the permanent secretary and printed in the issue of SCIENCE for February 7. As has already been noted here Professor T. H. Morgan, director of the Kerckhoff Laboratories of the Biological Sciences of the California Institute of Technology, was elected president of the association to succeed Dr. R. A. Millikan. Other officers elected at Des Moines are:

Vice-presidents and Chairmen of the Sections

A—Mathematics: G. A. Bliss, the University of Chicago
B—Physics: F. K. Richtmyer, Cornell University
C—Chemistry: James F. Norris, the Massachusetts Institute of Technology
D—Astronomy: D. W. Morehouse, Drake University
E—Geology and Geography: Edson S. Bastin, the University of Chicago

F—Zoological Sciences: W. A. Riley, the University of Minnesota
G—Botanical Sciences: E. J. Kraus, the University of Chicago
H—Anthropology: Carl E. Guthe, the University of Michigan
I—Psychology: Edwin G. Boring, Harvard University
M—Engineering: Frank B. Jewett, the Bell Telephone Laboratories
N—Medical Sciences: Louis B. Wilson, the Mayo Foundation
O—Agriculture: W. C. Coffey, the University of Minnesota
Q—Education: L. V. Koos, the University of Chicago

Members of the Council

Rodney H. True, the University of Pennsylvania
John C. Merriam, the Carnegie Institution of Washington

Members of the Executive Committee

Karl T. Compton, Princeton University
Robert A. Millikan, the California Institute of Technology

Committee on Grants

Arthur H. Compton, the University of Chicago

Board of Trustees of Science Service

Burton E. Livingston, the Johns Hopkins University

Finance Committee

A. S. Frissell, the Fifth Avenue Bank, New York

SCIENTIFIC NOTES AND NEWS

A BUST of Henri Poincaré, the great mathematician, will be placed in the hall of the Academy of Sciences, Paris.

IT is proposed, according to an Associated Press despatch from Paris, to confer on Mme. Curie the order of Commander of the Legion of Honor.

DR. WILHELM OSTWALD has been elected an honorary member of the Chemical Society, London.

PROFESSOR W. H. HOFFMANN, of the Finlay Institute, Habana, has been elected a member of the International Institute of African Languages and Cultures in London.

DR. ELMER A. SPERRY, at a meeting of the Engineering Association of Hawaii on December 13, was elected an honorary life member of that organization. Dr. Sperry was *en route* from Japan, where he had attended the World Engineering Congress, to the United States.

AN Associated Press dispatch announces that Orville Wright, "for the design and construction, with his brother, now deceased, of the first successful engine-propelled airplane," will be the recipient of the first Daniel Guggenheim Medal for notable achievement in the advancement of aeronautics. The award will be presented on the fiftieth anniversary of the American Society of Mechanical Engineers in Washington.

DR. LEE DE FOREST has been elected president of the Institute of Radio Engineers for 1930 to succeed Dr. A. Hoyt Taylor. Colonel A. G. Lee, radio engineer attached to the British Post Office in London, was elected vice-president. John V. L. Hogan and R. H. Marriott were reelected managers of the institute.

DR. HERBERT S. LANGFELD, professor of psychology and director of the laboratory at Princeton University, has been elected president of the American Psychological Association. Professor John F. Dashiell, of the University of North Carolina, and Dr. Arnold Gesell, professor of child hygiene and director of the psychological clinic at Yale University, have been elected directors.

ON account of the retirement of Dr. F. E. Smith, Professor F. J. M. Stratton, professor of astrophysics in the University of Cambridge, has been appointed acting general secretary of the British Association for the Advancement of Science for the period before the meeting of the association in Bristol in the autumn.

DR. R. L. KING, of the University of Pennsylvania, has been appointed associate professor of zoology in the State University of Iowa. Professor King will take up his work at the beginning of the second semester of the present school year.

WILLIAM EMBRY WRATHER, consulting geologist and petroleum engineer, of Dallas, Texas, has been appointed lecturer on the geology and economics of oil and gas at Yale University for the balance of the academic year.

DR. B. W. WEINBERGER has been appointed to the newly established chair of dental history and literature in New York University.

THE chair of geology in the University of Glasgow, recently vacated by Professor J. W. Gregory, has now been filled by the appointment of Mr. E. B. Bailey, of the Geological Survey.

PROFESSOR H. J. FLEURE, D.Sc., at present professor of geography and anthropology in the University College of Wales, has been appointed professor of geography in the University of Manchester.

PROFESSOR SYDNEY HOWARD VINES, who retired from the Sherardian chair of botany in the University of Oxford in 1919, after serving for thirty-one years, celebrated his eightieth birthday on December 31.

The title of emeritus professor has been conferred by the University of London on Dr. E. A. Gardner on his retirement from the Yates chair of archeology at University College, and on Dr. F. W. Oliver on his retirement from the Quain chair of botany at the college.

Dr. Louis A. Bauer, director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington since the establishment of the department on April 1, 1904, retired from this position on January 1, 1930, with the title of director emeritus. Provision is also made whereby if his health permit he may carry on studies during the coming year as a research associate of the institution. Mr. John A. Fleming, associated with Dr. Bauer as chief assistant in the Department of Terrestrial Magnetism since 1904, as assistant director for observational and administrative work during 1922 and 1923, and as assistant director in charge of operations since 1924, continues in charge of the work of the department with the title of acting director.

Professor Robert Robinson, of the University of London, has succeeded the late Professor W. H. Perkin as Waynflete professor of chemistry at the University of Oxford.

The promotion has been announced by the U. S. Forest Service of District Forester C. M. Granger, of the Pacific Northwest District, to the position of head forest economist in charge of the nation-wide Forest Survey now being initiated by the Forest Service. Certain phases of the survey, such as the forest resource inventory and the study of growth, will be carried out by the regional forest experiment station under the general direction of Mr. Granger.

Dr. Lucius Herbert Merrill, professor of biological and agricultural chemistry at the University of Maine, has been granted leave of absence and will devote a large part of his time to the work of state geologist, a position to which he was appointed last year by Governor Gardner. Dr. Merrill is a member of the class of 1883 and has served the university for 42 years, first as chemist in the Agricultural Experiment Station, and later as head of the department of biological and agricultural chemistry in the College of Agriculture. He is a brother of the late Dr. George Perkins Merrill, former head curator of geology of the National Museum at Washington.

Professor Emanuel Fritz, of the forestry division, College of Agriculture, the University of California, has left for Cornell University where he will be during the spring session exchange professor of lumbering in the forest school. The exchange is with Professor A. B. Recknagel, who has just completed a semester at the University of California.

Dr. Lewellys F. Barker, professor emeritus of medicine of the Johns Hopkins University School of Medicine, who has been lecturing at the University of California, expects to return to Baltimore in February by way of Panama, where he will attend the second annual congress of the Pan-American Medical Association.

Dr. James G. Needham, professor of entomology and limnology at Cornell University, will have charge of the work in field zoology at West Virginia University for twelve weeks, beginning about June 7. Transportation will be by motor cars and camps will be established, for a week or more each, at various parts of the state. The work will be carried on in cooperation with the field courses in botany so that a student may take one or both subjects during the summer.

Thomas Adams, general director of plans and surveys of the Regional Plan of New York and its environs, begins during the second half of the academic year a study for the new Harvard School of City Planning. He will conduct research on the optimum densities for residential distribution in English garden cities and suburbs. During the last part of the second half of the academic year Mr. Adams will give before the School of City Planning several lectures on the subject of his investigation.

Dr. H. de Forest, professor of botany at the University of Southern California, will be on sabbatical leave during the second half of this year. He will devote some six months to an investigation of the vegetation of southern California.

Professor Ernest E. Just, head of the department of zoology of Howard University, sailed on January 2 for Berlin where he will spend six months as guest investigator in the Kaiser Wilhelm Institut für Biologie, Berlin-Dahlem. Dr. Just was recently elected to the vice-presidency of the American Association of Zoologists.

Dr. Joseph H. Barach, for nineteen years a member of the staff of the Presbyterian Hospital of Pittsburgh, has been appointed director of the Falk Clinic, a free dispensary where eight hundred persons may be treated daily. The clinic, now under construction, is to be part of the medical center of the University of Pittsburgh and has been established by a gift of $900,000 from Maurice Falk and the late Leon Falk and Leon Falk, Jr., business men of Pittsburgh. Plans for the building were drawn by E. P. Mellon, architect, assisted by W. L. Smith. Dr. Michael

Davis, a member of the staff of the Rosenwald Foundation of Chicago, was consultant. The clinic will be the clearing house for the entire hospital group. Every department represented in the hospital group will be included in the clinic.

Professor G. H. Parker, of Harvard University, addressed the Mayo Foundation of Rochester, Minnesota, on January 2, 1930, on the "Secretory Action of the Nervous System."

The Stanford University Medical School announces the forty-eighth course of popular medical lectures to be given on alternate Friday evenings, beginning on January 10. These are: "Diabetes, the Cause and Cure," Dr. Horace Gray; "Some Sanitary Sins of the Orient," Dr. Alfred C. Reed; "Dental Caries as Viewed by the Bacteriologist," Dr. T. D. Beckwith; "What Medicine has to Offer the Nervous Patient," Dr. Henry G. Mehrtens; "Lessons from the Biography of Genius," Dr. Lewis M. Terman, and "Poisonous Animals," Dr. Karl F. Meyer.

Edward Stephen Harkness, of New York, has given to Yale University funds for the construction of dormitories on the lines of the colleges of the English universities. Five new quadrangles will be built and three existing groups reconditioned with the funds. Under the house plan from 200 to 250 students will live together under the leadership of a member of the faculty. The gift, it is understood, also provides for an endowment fund to be used as salaries for residential heads and for the establishment of the tutorial system of teaching. The amount is reported to be larger than the $12,000,000 that Mr. Harkness recently gave to Harvard University for the same purpose.

Harvard University will receive an unrestricted bequest of nearly $5,000,000 under the will of the late Stuart Wyeth, of Philadelphia.

The Commonwealth Fund will give this year and in 1931 and 1932 $35,600 to the Columbia Dental School to study the causes of dental disease. The study will be made in cooperation with a group at Yale University engaged in a similar project under a grant from the Rockefeller Foundation, and also with other research workers in this country and Europe.

Plans for the development of the department of chemistry of the University of Chicago, made possible by the new George Herbert Jones Laboratory, were outlined by Professor Julius Stieglitz, chairman, at a dinner which concluded the recent dedication program. The laboratory, gift of the Chicago citizen whose name it bears, provides facilities for more than a hundred research workers in chemistry. The cost was $665,000. The Rockefeller Foundation and the General Education Board have contributed $300,000 in endowment for the development of the staff of the department and for the purchase and maintenance of equipment necessary for their research work. In addition, the Chemical Foundation appropriated the sum of $10,000 a year for five years for research in chemistry applied to medicine. Pierre S. du Pont has given $10,000 a year for two years, to be expended in research in cancer from the chemical end, under the direction of Associate Professor Morris Kharasch. Strengthening of the staff, in anticipation of the improved opportunities afforded by the new laboratory, has already been achieved. Dr. Kharasch, of the University of Maryland, was brought to the University of Chicago a year ago. On January 1 Professor T. R. Hogness, now of the University of California, joined the staff as a permanent member. He will enable the department to develop more rapidly and intensively the application of light to the solution of chemical problems, especially those in connection with molecules and atoms. Dr. Preston Harris, at present of the department of physics, will join the staff in the spring quarter. His field of research is the application to chemical problems of the X-ray.

The fourteenth annual meeting of the Pacific Division of the American Association for the Advancement of Science will be held at the University of Oregon, Eugene, June 18–21, 1930. It is five years since a meeting of the association has been held in the Pacific Northwest, the last having been held at Portland in 1925. An attendance of approximately five hundred representatives of many of the associated societies and of several groups not formally associated is expected. The dormitories of the university will accommodate about four hundred. According to preliminary plans, a symposium on trees will be one feature of the program. Members proposing to present papers are reminded that titles must be sent in to secretaries of societies not later than May 1. Preliminary announcements will be sent out in the middle of March.

Through its applied mechanics division, The American Society of Mechanical Engineers will participate in the Third International Congress of Applied Mechanics to be held in Stockholm from August 24 to 29. The division has appointed a special committee, of which Dr. S. Timoshenko is chairman, to take care of the details, in connection with its part in this congress. The field of interest of this coming convention lies in hydrodynamics and aerodynamics, theory of elasticity, and rational mechanics. The applied mechanics division of the society is also arranging a tour of the most important European laboratories in mechanics. Following the Stockholm Congress there will be a congress on general mechanical engineering to be held in Liège, Belgium, from August 31 to September 7, which is being held at the same time as the Belgium International Exposition.

THE tenth summer term of ten weeks of the American School of Prehistoric Research, under the direction of Professor George Grant MacCurdy, of Yale University, assisted by Mr. J. Townsend Russell, Jr., of the U. S. National Museum, will open in Paris on July 1. The field to be covered includes Paris museums, Valley of the Somme at Amiens, Brittany, northern Spain with excavations near Santander, the Pyrenees, Dordogne with excavations at St. Leon-sur-Vézère and Switzerland. In addition, the students will have opportunities to do field work in Czechoslovakia under the supervision of Messrs. V. J. Fewkes, of the University of Pennsylvania, and Robert W. Erich, of Harvard University. Applications for enrollment should be made as soon as possible to Dr. George Grant MacCurdy, Peabody Museum, New Haven, Connecticut.

AFTER a stay of four months the Oxford University Expedition to British Guiana has decided to return to England. It is stated that the expedition, which is under the leadership of Major R. W. G. Hingston, has secured what is said to be the best botanical and bird collections yet made in the forests of British Guiana.

Industrial and Engineering Chemistry reports that a chemical research bureau, with American participation, has been established in Zurich, Switzerland, under the name of the Colloid Chemical Research, Inc. The purpose is not only to conduct chemical research, particularly in the colloid chemical field, but also to acquire patents and processes for commercial development and to erect laboratories in Switzerland and elsewhere.

THE U. S. Civil Service Commission announces examinations for associate and assistant agronomist, applications to be on file by February 12. The examinations are to fill vacancies occurring in the Bureau of Plant Industry, Department of Agriculture, for duty in the field. At present there is a vacancy in the associate grade at Bellingham, Washington, and there are vacancies in the assistant grade at Huntley, Montana, and Fort Collins, Colorado. The entrance salaries range from $3,200 to $3,700 a year for the associate grade and from $2,600 to $3,100 a year for the assistant grade.

DISCUSSION

THE MICROMETRIC MUDDLE

IN an article with this title published in a recent issue of SCIENCE,[1] Mr. John P. Camp discusses the use and the interpretation of the symbol μμ. One might infer from the penultimate sentence of his article that he thinks that such questions might properly be settled by the simple process of counting the noses of those on the two sides. However such a method may work in politics, it scarcely accords with scientific ideals and, if adopted, would lead to ever-increasing disorder and confusion. It is a matter of common experience that new terms and new uses of old ones are most enthusiastically proposed and most avidly seized upon by those least qualified to decide what is needed and what accords best with established custom.

The confusion to which he refers seems to have arisen from a very common, but incorrect, definition of the micron (μ). It is commonly defined as a thousandth of a millimeter, and this suggests that μ indicates the one thousandth part. Neither is correct. The length of a micron is equal to the one thousandth part of a millimeter, but the proper definition of the micron is the millionth part of a meter. In the metric system, all units of the same kind refer to the fundamental unit, in this case the meter. As we have the myriameter (10,000 m), the kilometer (1000 m), the hectometer (100 m), the dekameter (10 m), the decimeter (0.1 m), the centimeter (0.01 m), the millimeter (0.001 m), so we have the micro-meter—called the micron—(0.000,000,1 m). With but few exceptions, the symbol of each unit is the dyad formed from the initial letters of the prefix and the name of the fundamental unit. According to this rule, the symbol for the micron would be μm, but μ has been used universally, I believe. Not only here, but in every case, in the metric system the prefix micro- and the symbol μ denote the one millionth part; for example, microsecond, microgram, microfarad, micromicrofarad, microhenry, microhm, microlambert. Consequently, consistency demands that μμ shall indicate the millionth of a millionth, and nothing else, and that mμ shall indicate the thousandth of a millionth. Furthermore, both must refer to the basic unit, not to a subsidiary one.

The unfortunate use of μμ to indicate a thousandth part of a micron seems to have been introduced by Kayser in 1883. It is well sponsored and probably arose in the manner already indicated, but it violates two principles of the metric system: (1) The placing of a subsidiary unit on the same plane as its primary; (2) the introduction of two symbols to indicate the same thing. For these reasons its use should be discontinued.

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[1] SCIENCE, 70: 453, November 8, 1929.

It is difficult to see how the use of the correct symbols can lead to any misunderstanding, as they fit into a well-known and orderly scheme. Even if one suspected that a writer had used μμ incorrectly, the context would usually show unambiguously what he meant, and if it did not, then the writer should be given the benefit of the doubt and be made to bear the burden of any error so resulting. The only difficulty in discarding the incorrect use of μμ arises from the human disinclination to break a bad habit.

Mr. Camp seems to imply that the Bureau of Standards is primarily responsible for the use of mμ to indicate the *thousandth part of a micron.* Were that true, it would be one more reason for the citizens of this country to be proud of the bureau, for it is a move in the direction of order and simplicity. Sixteen years ago, Ch. Ed. Guillaume, who is the director of the International Bureau of Weights and Measures, stated,[2] "La notation μμ, souvent employée, est défectueuse et doit être abandonnée," and gave mμ as the proper symbol for the thousandth part of the micron.

To conclude: In the symbolism of the metric system, *the prefix* μ *denotes the one millionth part,* and the prefix m denotes the one thousandth part; a micron (μ) is the one millionth part of a meter and, consequently, is equal to 0.001 mm; a thousandth part of a micron is called a millimicron, it is the one *thousandth part of a millionth of a meter,* its symbol is mμ; a millionth part of a micron is called a micromicron, it is the millionth part of a millionth of a meter, its symbol is μμ. Any departure from this is a violation of principles identified with the metric system *and is to be deprecated as leading to disorder* and confusion.

N. Ernest Dorsey

National Research Council,
December 3, 1929

THE EFFECTIVENESS OF A PLANT QUARANTINE

The actual degree of effectiveness of plant quarantines in preventing the spread of insects is not known. Proponents of these quarantines will maintain that the presumption of effectiveness should be allowed them. The fact that the Mediterranean fruit-fly has not yet appeared in California will be ascribed by them solely to the vigilance of quarantine officers. The fly is not here. There has been a quarantine against it. Consequently the absence of the fly is to be credited to that quarantine. Opponents of the quarantines may doubt—or even sneer—as much as they please, but they can prove nothing.

Undoubtedly there are many peculiar factors entering into and influencing the spread of insects, even under natural conditions. Why, for example, should a single, isolated plant—as has been observed by the writer in field collecting—be heavily infested with a certain scale insect, while whole thickets of the same plant less than a hundred feet away have none of it at all? Why has the Mediterranean fruit-fly been so unexpectedly considerate as to confine its efforts in Florida purely to cultivated fruits, as is reported to be the case? We may agree whole-heartedly with a recent investigating committee which has remarked, "That infestations have not been found in adjoining states where much fruit was shipped previous to the discovery of the infestation [in Florida] is difficult to explain."[1]

One example which affords a clean-cut test of this matter is at hand. A mealybug (*Pseudococcus brevipes* Ckll.) occurs abundantly upon pineapples in the Hawaiian Islands. This insect is a general feeder and is established on various hosts in Florida, where it is quite common, and also in Texas, but is not known to occur in California. There is no reason to suppose that it will not live in at least some part of this state and upon some plants that are grown here, but although I have been identifying mealybugs for various county commissioners of horticulture for several years, it has never come to me, and it may be assumed that it is not in the state.

This insect is not supposed to pass the quarantine barriers and it is one of the insects that have commonly been reported as among the "pests intercepted" by the quarantine officials. The presumption would therefore be that its absence from California is due to the vigilance of these officials.

Yet I have several times taken this insect alive on bananas and pineapples in markets in this state. In order to check up once more I looked for it in a market a few days ago. The one pineapple in this market had several living specimens upon it.

The facts of the matter, then, are that this insect must have come into California alive many thousands of times since the quarantines were instituted. Yet it is not established in the state. Whatever credit the quarantine officials may assume to themselves for the exclusion of other pernicious species, they can not lay claim to such credit in this case. The presumption of their effectiveness can not be maintained. The reasons for the failure of the insect to establish itself here are biological.

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[2] "Recueil de Constantes Physiques," page 5, Gauthier-Villars, Paris, 1913.

[1] Official Record, U. S. Dept. Agriculture, Vol. 8, No. 46, p. 8. November 14, 1929.

With definite examples of this sort before us, those of us who are unconvinced of the value of the plant quarantines—except as a substitute for a tariff—may be pardoned a certain amount of reluctance to concede that presumption of effectiveness to which the supporters of these measures are prone to appeal. We may with equal justice claim that in all probability there are other cases where biological factors and not the quarantine officers have been the effective barrier.

G. F. Ferris

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THE DISTRIBUTION OF PAUROPUS

Pauropus huxleyi, a minute centipede-like animal with nine pairs of legs in the adult, was described by Sir John Lubbock. Specimens were found in England in 1866. Since then they have been reported from the continent of Europe, in the eastern states of this country and many other places. Actual records are from Sweden, Denmark, Germany, Austria, Italy, Chile, Paraguay, Argentina, Australia and Siam.

It was not until November, 1927, that I found them in California. Earlier records than this were of specimens in the New England region, Long Island, near Philadelphia and Indiana. The last record that I have found was by S. R. Williams and R. A. Hefner from Ohio.

In the summer of 1928 I found them in southern New York state. Since then I have collected them from a number of places. My first records were from southern California not far from Claremont in the college park under the live-oak trees, but I also found them in abundance in my own back yard or about a mile from the first location. I also found them near Laguna Beach in Orange County and in several situations in the San Gabriel Mountains, including one place among the pines at seven thousand feet altitude.

Two places in Mexico furnished specimens, although many other places were searched. One of these was from Lower California about a hundred miles below the border. Another lot was found not far from Mexico City. Several places were searched in Cuba without success. Neither were they found in Florida or other southern states, but in these last, at least, conditions were not favorable. Ideal places were found in many parts of California, Washington, Oregon, Utah, Montana, Wyoming and Idaho, but no specimens. However, several were collected in the deep coniferous forests on the slope of Mount Hood, Oregon, and some were found on Catalina and Santa Cruz Islands off the southern California coast.

Often, under certain conditions, it is not possible to find them in given localities, even though they are known to occur. If it is very wet or very dry they may not be seen, however abundant they may be at other times. We have not found them easily by means of funnels or sieves, and this may account for their apparent infrequency. The under-sides of stones or logs slightly dampened by recent rains seem to be the best situation to see them. Here they may be found among the more numerous small white Collembola.

After studying a considerable number of specimens from one place and comparing them with others of distant regions I at first came to the conclusion that there were about as many differences between individuals in one place as between specimens from widely separated localities, but more detailed study has convinced me that at least two distinct forms are in my collection. These, according to the descriptions of Hansen and others, are distinct genera. There is, then, a good chance of a number of species in my collection.

They are difficult to study in detail as they are neither small enough nor large enough for the usual methods to be employed in determining the distribution of the setae, proportions of the joints or other characters which aid in distinguishing one species from another. These that I have at present belong to the genera Pauropus and Stylopauropus.

I wish to have further material, and I should be glad if any collectors who may find specimens of these interesting forms will communicate with me as soon as possible.

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AN UNBOUND TEXT AND NOTE BOOK

The writer has been trying an experiment which has worked out so satisfactorily in one direction for him that it has seemed others might be interested in trying the same thing, if they have not already done so.

At the time of publication of a recently issued book the publishers were requested to furnish one unbound copy with holes punched at appropriate places on the left hand margin. The intention was to use this copy in loose-leaf form for work in the classroom in a course involving material covered by the book. In such a case the primary advantage of a loose-leaf book lies in the fact that one can readily insert blank pages for notes concerning corrections, new material or anything else of value for the work in hand. In fields of science experiencing rapid developments and changes this seems particularly desirable. Such an arrangement makes of the book a combination text and note book for the instructor. A second advantage, which is of much less significance, lies in the fact that the loose-leaf type of book will open easily and lie flat on the instructor's desk, if a suitable binder is used.

As no commercial binder could be found having capacity for a sufficient number of pages, a homemade one was devised. Three half-round book rings (preferably with a hinge at either end of the flat section and the opening in the middle of the circular section) were soldered along the flat section to one side of a piece of brass (twenty-two gauge) at a distance apart to correspond with the holes in the sheets of the book. The piece of brass was slightly longer than the sheets and slightly wider than the length of the flat section of the rings. A two-piece folding back was made by cutting down ordinary folders of heavy press board designed for holding laboratory reports. In order to hold the folding backs in place a piece of sheet aluminum of the same size as the sheet brass was placed on top of them directly over the piece of brass, and the whole thing fastened together by means of round head, split paper fasteners put through holes made in both the pieces of metal and the press board cover.

Although such unbound copies of books are ordinarily unavailable, it seems probable that publishers would be willing to supply them if there was a demand, and also that suitable loose-leaf binders would be relatively easy to produce. The page proof, having every second page blank for notations, would be even better than the regular sheets if it was printed on the same grade of paper as the book. Its only disadvantage is the increased thickness.

M. G. Mellon

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PEDOLOGY OR CHTHONOLOGY?

In Dr. P. E. Brown's interesting discourse on "The New Soil Science," which appeared in the December 27, 1929, issue of Science, "pedology" is given as a synonym of soil science. Dr. Brown says: "Soil science or pedology, as it is now coming to be called, is not new."

Do Dr. Brown and other soil scientists who use the term "pedology" as a designation for their specialty know that this word has been employed for thirty-three years as the name of the science of the child, or child-study in its broadest sense? The term, which is also spelled paedology or paidology, was probably introduced by O. Chrisman in 1896.[1]

If soil specialists are in need of a name for their science and wish to conform to the criteria of etymologic excellence, why do not they choose the term *chthonology?* The word chthonography, a descriptive treatise upon soils, is now in limited use. If they should fear cacoepy in the use of the proposed neonym, they might give thought to adopting the term *humology*, which would no doubt be acceptable to lexicographers.

William A. Hamor

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SCIENTIFIC BOOKS

Icones Farlowianae, Illustrations of the Larger Fungi of Eastern North America. By William Gibson Farlow. Farlow Herbarium, 20 Divinity Avenue, Cambridge, Massachusetts. 1929. 103 colored pls. $40.00.

The mycologists of the old world have, during the last two centuries, supplied students of agarics, in rather numerous Icones and other publications, with an abundance of colored figures of these fascinating plants. With the exception of the Icones of Boudier, where the scientific training of the mycologist was to a remarkable degree linked with the talent of a real artist in the same man, no illustrations of mushrooms have appeared which remotely approach the beauty and scientific accuracy of the plates in the volume before us. It is, furthermore, the first extensive collection of colored plates of American agarics to be conceived, executed and published in this country.

As explained in the Introduction by Dr. E. A. Burt, who edited the work and wrote the accompanying descriptions, all the 103 plates included in this volume were completed as well as printed by 1908. The author employed two successive artists. The larger number of paintings included in the published volume were made by Mr. Joseph Bridgham; later, from 1902 to 1911, the author employed the well-known mycological artist, Mr. L. C. C. Krieger. The eminently successful reproduction of the colored drawings by the Boston Heliotype Printing Company enhances the value of the finished plates in a large measure. For the writing of the text and the final touches in the editing of the work, mycologists have to thank Dr. E. A. Burt, whose loyalty to his departed friend and teacher made of the difficult task a labor of love.

Dr. Farlow, fortunately, wrote the preface himself, an *apologia*, characteristic of the man. "The aim of the author," he writes, "has been to furnish to those who are not in the possession of large libraries and collections the means of identifying the more striking and characteristic of our larger fungi," and, on the other hand, he hopes that such accurate presentations of endemic American species and of species which also occur in Europe may keep the scientific man from making erroneous identifications of these fungi or confusing their nomenclature.

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[1] See *Am. J. Psychol.*, 12: 268.

The author has shown his usual acuteness in the matter of the forms selected. No one genus of agarics is given undue prominence; but that sense of proportion, so often lacking in teachers, by which we pass from the special to the general, from the known to the unknown, is beautifully exemplified in the selections made. Only three examples of the deadly Amanita group are included: *A. verna, A. solitaria* and *A. porphyria.* A plate of the typical "parasol mushroom" will impress that species on any beginner. Similarly, other plates depict strikingly such plants as *Cantherellus floccosus, Agaricus abruptibulbus, Cortinarius mucifluus, Cortinarius squamulosus, Claudopus nidulans* and other such common species.

Twenty-one species of Boletus are depicted: *B. sublutens, B. elegans, B. americanus, B. punctipes, B. granulatus, B. badius, B. dichorus, B. auriporus, B. piperatus, B. rubinellus, B. Ravenellii, B. subtomentosus, B. Russulii, B. speciosus, B. ornatipes, B. eximius, B. luridus erythropus, B. Frostii, B. chromapes, B. cyanescens* and *B. castaneus.* This list, with the exception of the rare *B. rubinellus* Pk., can be duplicated in the wooded northern portion of the United States and in Canada, as far west at least as the Rocky Mountains, and although the plants from which the illustrations were made were doubtless collected in northern New England, they represent a large proportion of the Boletus flora in the country mentioned and the favored possessor of the "Icones" can identify most of his findings with ease. Here, again, Dr. Farlow's experience in the field made him realize that in this group in which descriptions alone leave much to be desired, an illustration is above all essential. The individual species of this genus are very variable in appearance from the effects of weather conditions during their development, and the selection of such typical specimens as here represented is most happy. The autonomy of *B. punctipes* Pk. has been much questioned, but there is no doubt that it is a good species, and although it is oftener paler when fresh than here shown, the figures are quite convincing.

Among the agarics figured, thirty-nine are marked edible. With the exception of *B. luridus,* and possibly *B. rubinellus* and *B. Frostii,* the Boleti shown have nothing against them, although Dr. Burt refrains from marking some of them as to edibility.

A very limited number of species belonging to genera where the plants are small or minute have been included. Thus, there are only five species of Inocybe shown, one plate with two species of Leptonia, while the genera Mycena, Galera and Psathyra are not represented. In view of the fact that no microscopic characters are shown on these plates, it would have been very unwise to include species of these genera. During the last fifteen years or more, the study of the microscopic details found present and known to be of taxonomic value for the species of these genera has brought about a temporary uncertainty in the taxonomic placement or identity of the older species. The few species that are depicted can be recognized fairly well by external characteristics.

In the genus Naucoria there are two old European species, *N. Christinae* and *N. hilaris,* both of which are rare, except in local areas, and both of which have somewhat the aspect of *Hygrophorus conicus.* The fine plate of *N. Christinae* in the "Icones" should help in determining its geographical distribution. In thirty years of collecting the present writer has failed to locate any of this species, but has collected its nearest relative in the Adirondack Mountains. The latter grows on rotten wood.

Five newly named and described species are illustrated: *Inocybe amarescens* Farlow and Burt, *Lepiota brunnea* Farlow and Burt, *Tricholoma oliveum* Farlow and Burt, *Stropharia rugoso-annulata* Farlow and *Stropharia subcaperata* Farlow and Burt. The last species is, unfortunately, well described in the American literature as *Stropharia depilata* Fr. No hint is given in the text of the "Icones" that this American plant does not correspond to that of Europe.

Among the species of agarics rather rarely seen throughout this country and which are perfectly figured in the "Icones" may be mentioned: *Armillaria robusta* Fr., *Armillaria ponderosa* Pk., *Tricholoma decorosum* Pk., *Crepidotus dorsalis* Pk., *Entoloma cuspidatum* Pk. and *Gomphideus viscidus* var. *testaceus* Fr. Finally, near the end of the volume, several examples of Gasteromycetes, Polypori and Ascomycetes are to be found.

The intrinsic value of the book is to be found in the fine judgment displayed in the selection of material, in the infinite care taken in planning the details and in the ability to employ, without taking count of the cost, men who could put on paper that which nature had wrought and retain its purity of beauty and at the same time its scientific meaning.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE EFFECT OF ULTRA-VIOLET IN PRODUCING FUSION OF EGGS OF CHAETOPTERUS

During the summer of 1926 at the Marine Biological Laboratory, Woods Hole, Massachusetts, while repeating some experiments on the effects of ultraviolet radiation on eggs of *Chaetopterus* before insemination, in order to preserve series of them for cytological study, I noticed during the cleavage stages a tendency of the eggs to fuse. Such fused eggs developed as far as the trochophore stage, as many as fifteen eggs frequently taking part in the fusion. This result is best obtained by an exposure of sixty to seventy seconds, the eggs being 21.5 cm distant from a Cooper-Hewitt mercury vapor arc lamp. Since the effect of ultra-violet radiation at lower exposures, namely, thirty, forty and fifty seconds, produces profound alterations of the cortex, as I shall show in a forthcoming paper, I assume that the fusion due to longer exposures is likewise attributable to changes in the cortex. For example, in observations made on eggs inseminated after radiation, on August 12, I found the next day innumerable fused eggs. Some fused masses were made up of twelve to fifteen eggs. Subsequently, it was learned that fusion is more readily brought about in dishes containing closely crowded eggs, and in dishes with few eggs in which the eggs are brought into close proximity. The fusion therefore, is primarily the result of radiation, and not of overcrowding, since of two equal lots of eggs from the same female—one lot inseminated with and one without previous exposure to the ultra-violet rays and suspended in equal volumes of sea-water—fusion takes place only in the exposed lot. Eggs centrifuged before insemination, that show while living a gray cap which after fixation with solutions containing osmic acid proves to be a disk of oil drops, behave in the same way.

Ultra-violet radiation has another interesting effect on eggs of *Chaetopterus.* In the swimming stage, the single trochophores show the apical tuft of long cilia displaced sometimes as much as 90°. In the majority of cases, however, this displacement amounts to about 75°. This result seems to indicate a change in the original organization of the egg. While it is true that ultra-violet radiation induces some eggs to differentiate without cleavage, the types here described show fairly normal cleavage, especially after the shorter exposures.

I might point out also that at times normal fertilized eggs of *Chaetopterus* used during these observations failed to form a yolk lobe. This is invariably a sign that the eggs are not in optimum condition.

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A SIMPLE METHOD FOR EXPERIMENTAL PARTHENOGENESIS

Hypertonic sea-water is undoubtedly the simplest method for the experimental initiation of development. Hypertonicity is brought about by the addition of concentrated salt solution to the sea-water. The salts most commonly used are sodium, potassium and magnesium chloride. In practice, one makes up a 2.5 M solution of the first or second, or a 1.25 M solution of the third, varying proportions of the molar solution and sea-water being employed.

A very simple method for experimental parthenogenesis is as follows. To clean filtered sea-water, crystals of Na_2SO_4 are added to excess. After the supernatant sea-water has become perfectly clear, it is decanted. Eggs exposed to this sea-water plus Na_2SO_4 for thirty to sixty minutes show a high per cent. of cleavage and plutei on return to normal sea-water. While in the solution, the eggs show separated membranes. A nicer method is to take the supernatant sea-water after the addition of the Na_2SO_4 in excess and add it to sea-water in varying proportions. For example, one may set up dishes in a series, the first of which contains the Na_2SO_4 sea-water solution alone; the second, nine parts of the solution plus one part of normal sea-water; the third, eight and two parts respectively; the fourth seven and three, etc. To each dish equal amounts of eggs from the same female are added. Eggs are then transferred at fifteen-minute intervals during a period of two hours. In this way one may take into account any variations in response of eggs during a given season to exposure to hypertonic sea-water.

E. E. Just

THE AMOUNT OF OSMIC ACID IN FIXING SOLUTIONS NECESSARY TO BLACKEN FAT

Fixing agents containing osmic acid are generally conceded to be the best for cytoplasmic fixations. There are several difficulties that militate against successful results with such agents. Preparations which the worker oftentimes describes as "over-osmicated" stain very poorly with Heidenhain's iron hematoxylin. Since this stain is so generally employed by cytologists fixatives containing osmic acid are less frequently used than others. Bouin's, for example, is many times preferred. Some of the difficulties in the way of successful results with osmic acid in combination with other chemicals may be removed. One of the chief obstacles to success is the amount of osmic acid employed.

In the first place, most of the osmic acid on the market is of inferior grade and, what is perhaps just as important, not always of the weight labeled. Best results are obtained with the best quality of the acid. If a given tube supposed to contain one gram of osmic acid actually contains more, then what the worker makes up as a 2 per cent. solution is obviously of greater strength. Working with some of these inferior grades of osmic acid, tubes of which frequently contain more than one gram, I have found that I could get very satisfactory results by using as little as 0.75 cc of osmic acid in Fleming or Meves solution. Indeed, in some cases, the amount of acid used was less than half this amount. The cytoplasm is very well fixed, and the staining with iron hematoxylin leaves little to be desired. Such small amounts of osmic acid have been successfully employed in the fixation of most diverse types of cells. The criterion for the amount of osmic acid necessary for good cytoplasmic fixations is that which will blacken the oil drops in the centrifuged uninseminated egg of *Arbacia*. One need simply to prepare a solution of 1 gram of the acid in 50 cc of distilled water, then take 4 or 3.5 cc of this with chromic and acetic acids as used in Fleming or Meves solution, and prepare also other solutions using instead 2, 1.5 and 0.75 cc of osmic acid. Eggs after centrifuging are placed in these solutions for thirty to sixty minutes, after which they are washed in several changes of tap or distilled water and examined under the microscope. If the disk of oil drops, the so-called gray cap in the living egg, is blackened in that solution containing the least amount of osmic acid, this constitutes sufficient evidence that enough of the acid has been used. After the use of these solutions containing small amount of osmic acid, the cells are perfectly preserved, both as regards nuclear and cytoplasmic structures. After iron hematoxylin, the cytoplasm is a clear pale blue, mitochondria are stained dark blue and the chromosomes after breakdown of the nucleus are stained black. Results with this method are infinitely superior to those obtained by the so-called weaker Fleming. That is to say, in my experience at least, it is better to alter the amount of osmic acid alone, leaving the chromic and acetic acids in the proportions originally given by Fleming and Meves.

E. E. JUST

SPECIAL ARTICLES

VARIATION IN THE PERCENTAGE OF PROTEIN IN THE GRAIN OF A SINGLE WHEAT PLANT

THAT a plant may vary markedly in composition is common knowledge to all engaged in plant investigations. Causes and significance of such variations, particularly of the percentage of given proteins in wheat, have been the subject of much study, because of the relation this property of grain has to the quality of bread. As information was desired on the probable range of variation in the percentages of protein in the grain of single wheat plants, experiments were performed that were designed to obtain marked differences in this character of wheat. Some of the data which were obtained are given in the following table. The values given are those of the percentages of protein in the grain of different heads on the same plant. They were chosen as representatives of the lowest and the highest protein grain grown on an individual plant, but are not to be considered as the lowest or highest values that possibly could have been obtained.

TABLE I

VARIATION IN THE PERCENTAGE OF PROTEIN IN THE GRAIN OF DIFFERENT STALKS OF THE SAME WHEAT PLANT

Variety	Percentage of protein		Difference	
	Low	High	Actual	Percentage
Bunyip	13.6	17.6	4.0	30
Cedar	12.3	18.6	6.3	57
Dart's Imperial	10.9	11.1	.2	2
Early Baart	10.4	12.2	1.8	17
Fulcaster	8.2	11.4	3.2	39
Hard Federation	11.8	17.3	6.5	55
Sonora	6.4	14.0	7.6	119
White Australian	10.2	13.0	2.8	27

Variation in the percentage of protein in wheat is directly related to that of the supply of nitrogen available to the plants at different growth periods—the later in growth a given supply is absorbed the higher the protein content of the grain. Thus an essential feature of the experiment was that of providing conditions whereby a given supply of nitrogen would become available late in the growing period of some stalks and early in case of others. This required that each plant have two distinct crops of stalks, one that arose early in its life and the other late. The requirement was obtained by planting seed in soil deficient in nitrogen in order to restrict stalk formation of the early growth period to one culm per plant. But later in growth—ninety days after planting—an application of 250 mgs of nitrogen per plant was added to the soil in the form of $NaNO_3$ in order to induce new stalk formation. Soon after this treatment tillers arose on various plants and thus two distinct crops of stalks, each capable of bearing grain, were produced. Because of the differences in time of the inception of these two crops of stalks on a plant, marked differences were obtained in their ripening. Usually, but not invariably, the grain of the parent stalk ripened before that of the tillers. As the amount of nitrogen supplied to each plant was more than the parent stalk could absorb but less than that which the tillers could utilize, the required conditions were met, namely, that of providing an ample supply of nitrogen during the later growth period of some stalks of the plant and early in case of others. The former produced high protein grain, the latter low protein grain.

The length of the interval between the ripening of the grain of two stalks on a plant or that of different plants grown under similar conditions appears to be of considerable importance and related to variation in the protein content of wheat. The correlation appears to be: the larger this interval, the larger the differences in the protein content of the grain. From these circumstances it follows that uniform ripening of all heads is an essential condition for the production of wheat of low variability. Inspection of the datum shows that a difference of one day or less in the ripening of two heads of wheat of some varieties can be detected in the composition of the grain. For example, the differences between the high and the low values of Cedar, Hard Federation and Sonora are 6.3, 6.5 and 7.6, respectively, which is equivalent to the accumulated change (difference) of 0.1 per cent. per day of the indicated amounts for 63, 65 and 76 days, respectively. But as the difference in time of ripening of the two crops of Cedar was only 36 days, the total difference of 6.3 is equivalent to a daily change (difference) of .17 per cent., a figure far above that of the experimental error in the method commonly employed for the determination of protein in wheat grain.

That a difference of one day in the ripening of two heads of wheat, or even of a few hours as happened to be the case in some varieties, can be detected in the composition of the grain appears at first consideration inconsistent with the general observation of the relationship between these circumstances. Mere change in the rate of desiccation or hardening obviously can not affect the ultimate percentage that a given constituent thereof has to the whole. As the protein content of wheat grain resolves itself into a relationship between two variable factors: (*a*) the amount of nitrogen available for grain, (*b*) the amount of grain in which a given quantity of nitrogen will be stored, so the correlation found in the variations in time of ripening of wheat with that of the protein content of the grain indicates that the time between final ripening and the period when the causes for variation can be operative is a fixed interval. In the case at hand the relationship is explained that the supply of nitrogen available for absorption was less than the potential quantity which would have been absorbed were it present, and the percentages of nitrogen found in two different heads of wheat indicate the quantities which are proportional to the proximity to harvest that comparable rates of the absorption of nitrogen were maintained.

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GLUTATHIONE IN PLANT TISSUES

GLUTATHIONE, because of its apparent function in the fundamental process of respiration, has become a substance of great interest. In 1927 Fink[1] published a micro method for the determination of glutathione in insect tissues. This method has been used by the writer in an attempt to determine the distribution of the dipeptide in plant tissue.

In making the determinations thin free-hand sections of the tissues were made. Immediately a solution of hot dilute acetic acid (approximately 20 per cent.) was poured over these. After a few seconds the acid was drained off and the sections were covered with 5 cc of a saturated solution of ammonium sulphate, $(NH_4)_2SO_4$, and 6 to 10 drops of a 5 per cent. solution of sodium nitroprusside, $Na_2Fe(CN)_5(NO) \cdot 2H_2O$. The tissue was allowed to stand for at least twenty minutes to insure the penetration of this solution. The section was then removed with enough of the solution to keep it moist. Several drops of dilute ammonium hydroxide (one part in three parts of water) were added. On the addition of the ammonium hydroxide a color, pale pink to a vivid purplish-red, flashed up through the tissues. This color lasted for a few seconds only, although longer in some tissues than in others. The difference in the intensity of the color is thought to be due to the difference in the amount of reduced glutathione present in the tissues.

Representatives of the different divisions of the plant kingdom were tested. The following examples are typical of the results obtained.

(*a*) *Thallophytes.*—Both Fungi and Algae were used. In sections of fresh sporophores of *Coprinus*, vivid color showed in the lamellae and extended gradually through the stipe. In *Rhozipus nigricans* the young sporangia showed a slight flash of color, but no reaction could be observed in the hypha under the microscope. Portions of young mats of *Aspergillus niger* and of *Fusarium* sp. showed brilliant color. Water extracts of these and of colonies of *Erythrobacillus prodigiosus* responded to the reaction. The hypha is probably so small that the amount of reduced glutathione present does not give sufficient color to be discernible. Portions of fresh yeast cake gave a brilliant color, yet no color could be seen in the individual yeast cell.

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[1] Fink, SCIENCE, 65: 143, 1927.

No color reaction was observed in either *Spirogyra* or *Zygnema*. This may be due to the small amount of the dipeptide in the slender filaments, or it may be that the color was disguised by the large chloroplasts.

(*b*) *Bryophytes.*—Liverworts and ferns were used. Sections through the expanded tops of the male and female gametophytes of both *Marchantia polymorpha* and *Reboulia* sp. showed color in the antheridia and archegonia. The reaction occurred in the antheridial contents in crushed antheridia of *Mnium* and in the region of the spores in the crushed immature capsule.

(*c*) *Pteridophytes.*—Young gametophytes of *Pteris aquelina* showed color in the antheridia and archegonia and a suggestion of color in the young rhizoids. In sections of the rhizome and uncoiling fronds of *Woodsia* sp. a flash of color showed in the meristematic regions and in the vascular bundles. The color, though not the characteristic pink or purplish-red because of the presence of pigment, was evidently, from its behavior, the same type of reaction obtained in other tissues.

(*d*) *Spermatophytes.*—Sections of the seed of *Pinus edulis* showed pronounced color in the embryo, especially at the tip of the hypocotyl, but no color in the megagametophyte. In the Angiosperm, inflorescences, embryos and parts of the flowers, stems and roots responded to the test. In *Brassica oberacea* var. *botrytis* and in *Asparagus* sp. vivid color occurred in those spots where the new floral parts were forming. A paler pink marked the region of the vascular bundles. Sections through the grains of *Zea mays* and *Hordeum* sp. gave no color in the endosperm, but color showed throughout the embryo. The cotyledon was a faint pink, but the plumule, the primary and the secondary radicles were a vivid color.

In the flower the most vivid color occurred in the ovules and throughout the pollen grains. No color was observed elsewhere in sections of the ovaries and anthers except a faint pink in the vascular bundles.

Herbaceous and woody stems, bulbs and tubers were tested. *Lycopersicon esculentum* and *Asparagus* showed color in the region of the phloem. In the latter the color quickly spread throughout the vascular bundle. Twigs of *Prunus Persica* one, two and three years old showed color in the region of the phloem and the cambium. In twigs from staminate and pistillate trees of *Salix*, color occurred in the phloem and cambium, but there was no apparent difference in the intensity of the color in the twigs from the staminate and the pistillate trees. *Gladiolus* bulbs showed faint color throughout the bulb with a more vivid color in the vascular bundles of the leaves and a brighter color in the flower buds. In tubers of *Solanum tuberosum* a well-developed color appeared in the region of the vascular bundles and an intense color in the tip of the bud. A section through the terminal bud of the sprout showed vivid color in the axillary buds with faint color in the phloem.

Longitudinal sections through the apex of primary and adventitious roots showed no color in the root cap. In the embryonic region the color was vivid but became very faint in the region of elongation. In the stele, however, the color extended back into the younger portion of the region of differentiation. The secondary root tips also showed a vivid color. A cross section of the stem of *Lycopersicon esculentum* through an embryonic adventitious root showed color in the vascular bundles of the stem and a much more vivid color in the cone of the embryonic root.

The results obtained by the writer on the distribution of reduced glutathione in plant tissues as indicated by the nitroprusside test show that it occurs throughout the plant kingdom with the exception of the algae. The apparent absence in the latter may be due to the methods of examination and the difficulty of observing color in the thin filaments and highly pigmented material. The substance occurs in those cells which have the capacity of producing new cells—in the primary and secondary meristematic regions of the roots and stems and in the reproductive organs. In addition to these regions it is found in the vascular bundles of those plants which possess vascular systems. In the Angiosperms this substance occurs in the phloem. With the exception of the phloem, the areas which react to the nitroprusside test are rapidly growing areas. There is apparent correlation, therefore, between meristematic tissues which have a high respiratory rate and the areas giving the reaction for reduced glutathione.

Sections of viable corn grains and corn grains which had lost the ability to germinate because of age were tested with nitroprusside. There was no apparent difference between the color obtained in these.

The embryos[2] of corn grains exposed to X-rays[3] at 120 KVP, 4 ma, 18 cm for 94 minutes showed a more intense color throughout than the embryos of un-

[2] Tunnicliffe, *Biochem. Jour.*, 19: 149–8, 1925.

[3] The writer is indebted to Dr. L. J. Stadler for treating the corn and barley grains with X-rays.

treated corn grains. Exposure for 144 minutes increased the intensity of the reaction.

The embryos of soaked barley grains exposed to X-rays for one, two, four and eight minutes showed an increase in the intensity of color in the one-minute exposure with a change in the quality, and decreased intensity of color in the two- and four-minute exposures. The eight-minute exposure showed a very faint pink color.

Attempts were made to find a method for a quantitative determination of reduced glutathione in the higher plant tissues. Tunnicliffe's[2] quantitative method was tried with yeast with results somewhat lower than those obtained by him. The same method was applied to the tissues of higher plants, but the attempts were unsuccessful because of the writer's inability to eliminate the pigments and at the same time retain the substance which reacts with nitroprusside.

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ON THE RECOVERY FOLLOWING LESIONS IN THE CEREBRAL CORTEX

THE recovery of functions following lesions in the cerebral cortex is a common "observation" which has received little or no thorough study. In the literature on this subject that was accumulated during the World War, Hollander has found numerous cases in which the patient, after having lost large quantities of nervous tissue, is said to have "entirely recovered his mental faculties." In many cases the patient demonstrated this complete recovery by sticking out his tongue and walking across the room when told to do so by the attending physician. Obviously a little more testing is necessary before we shall care to place much confidence in such reports.

In the work with experimental lesions the same error has been not quite so obvious. Complete recovery of function has been reported to be found in experimental animals when there have been either no tests at all, or only tests of gross movements such as locomotion. Employing such methods, the major question is, "How great a lesion may be made without producing loss of function?"

If adequate tests are used, if those reactions are tested which the animal finds difficult to make, the interest undergoes a reversal. The question now becomes, "How small a lesion may be made in the cortex and still produce a measurable loss in the animal's reaction capacity?"

In our investigations we are employing cats. The animals are tested before and after the operations on such situations as climbing a vertical screen, to which they hold with three paws while they stretch for food with the fourth; high jumping; climbing a vertical ladder; crawling through small holes; jumping up to catch a rope and hanging there by the forepaws while the food is captured by the head; stretching down from a platform; walking across a narrow bar on which there are obstructions; reaching through a small hole at various angles in both the vertical and horizontal planes; removing a bag from the head, and a few others of a similar caliber.

The potentialities of such an attack may be illustrated by some of the results obtained on three animals.

We removed from the parietal region of No. 32 an amount of tissue which we judged to be about equal to all that forward of the cruciate fissure. Six weeks after the operation our tests could reveal no loss of motor reactions. In the tests made before the operation No. 34 used his left forepaw much more often than he used the right. A lesion about a quarter inch wide and three eighths inch deep was made in the arm area of the right motor cortex. No tissue was removed. Six weeks later the animal was completely right handed. In those situations which demand skilful use of the left forepaw to obtain food the animal goes hungry. All the tissue forward of the cruciate fissure was removed from No. 35. Six weeks later the animal was unable to perform any of the required reactions.

It is interesting to note that at the time of the second test all these cats were "normal" to a casual observer.

There is little evidence here that there is "segmental localization," "equipotentiality of the cortex," "vicarious assumption of function," or that the "brain acts as a whole." Our work, so far, has produced results which indicate that there is organization in the central nervous system. In any organization certain parts have certain functions.

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MEDICAL AND OTHER SCIENCES[1]

AN INQUIRY OF WHAT IS SCIENCE WHEN IS IT TAUGHT SCIENTIFICALLY

By Dr. A. J. GOLDFORB

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SCIENCE to-day plays an intricate, permeating and dominant rôle in our lives. It is not my intention to weary you with evidence in support of this thesis, to list the names of the various agencies engaged in science or the numbers of men and women so engaged or the ever-increasing millions of dollars expended, or to name the institutions, industries, occupations, mental attitudes and thoughts profoundly modified by science. Nor will I cite the figures of the ever-increasing numbers of "students" or numbers of hours or increasing budgets for science teaching from kindergarten to university. Nor is it necessary to list the amazing increase in the number of journals of science or the bewildering increase in the number of published manuscripts, the despair of the librarian as well as of the scientist. There is to-day probably no field of human endeavor which is not affected by the advances in science. Truly may it be said that science plays a dominant rôle in our lives.

It might then be assumed that the meaning of science, its essential characteristics, the tests by which it may be distinguished from pseudoscience or non-science, the methods of teaching science scientifically would be widely and clearly understood. The startling fact, however, is that science is probably more widely not understood or misunderstood than in any previous period of history. Misunderstood not only by the armies of schooled (so-called educated) masses, but by the teachers and practitioners of science. The extent to which unscientific science is taught in our schools is amazing.

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[1] Address of the retiring vice-president and chairman of Section N—Medical Sciences, American Association for the Advancement of Science, Des Moines, Iowa, December, 1929.

It is widely believed that chemistry, agriculture, medicine, etc., are coequal with the sciences of advertising, linguistics, archeology, music, literature; that the science of paleontology belongs to the same brood as salesmanship and labor unionism; that the science of engineering is akin to the science of voice placement, taxonomy, crime, anatomy, history, religion, sociology, physiology, plumbing, Christian science, *ad nauseam*. One is amused, chagrined, disgusted, according to one's temperament.

All of you may admit biochemistry, physiology, mathematics into the realm of sciences. Some of you may grudgingly tolerate some branches of medicine, engineering, agriculture. Few will concede a place for history, philology, salesmanship. Probably none will yield a place to plumbing, Christian science, painting. But would there be agreement among you? Think of the disagreement among the schooled ("educated") members of our population.

Is science definable? Is it a fixed entity, like dollar, mile, gram; or is it a variable entity, whose limits may be defined, such as color, sound, taste, insurance rates; or is science an entity whose limits may not be clearly defined, such as instinct, thought, government, religion, art, etc.? Is it knowledge or only certain categories of knowledge or is it not knowledge at all?

Science, like paleontology and civilization, embraces a historical series from the simple to the complex. The earliest and most primitive stage may be characterized by the accumulation of new and exact facts or observations, but seen through eyes beclouded and distorted by beliefs in the ubiquitous and ever-present gods, demons, spirits dominating and controlling man and his environment.

A later stage in the development of science may be characterized by the systematization of such accumulated facts, or the formulation of "laws" such as the laws of alchemy, the Ptolemaic laws in astronomy, the pre-Galenic laws in medicine, the Aristotelian laws of nature. These were interesting mixtures of rare insight, exact and inexact description, mythology, hearsay evidence, unverified and unverifiable facts and laws—all subject to the whims of gods, saints and spirits.

The next stage in the evolution of science consisted in the gradual elimination of anthropomorphism and deism both from observation of facts and formulations of laws, but yet unverified and unverifiable, such as the bizarre pharmacopoeias up to the eighteenth century, the theories of evolution prior to Lamarck, the systems of classification including Linnaeus, the later alchemy.

Mathematics had in the meantime been developing most rapidly. Starting with immutable and absolute truths, the science of mathematics grew by further testing and elaboration of these fundamental truths.

The next great development in the natural sciences arose with the growth of chemistry and physics. It no longer sufficed to accumulate facts or observations, or to elaborate unverified and unverifiable laws or to hypothecate causes. The new era in science demanded experimentation, *i.e.*, the determination of the immediate or proximate mechanistic cause or causes of the phenomenon. The scientist started with observations or facts. He then devised an experiment in which the profoundly complex conditions associated with a phenomenon were reduced to constancy or were known. Only one condition or factor was unknown. The experimental conditions differed from the control conditions by this one, simple or compound, unknown factor. The object was to determine the rôle of this unknown or x in the phenomenon. He must produce or modify the phenomenon at will, to obtain the same results, under the same experimental conditions. From such experiments, new phenomena or new unknowns or new methods of analysis of the x arose, which new x must again be tested by suitable experimentation. The attitude of mind, the experimental procedure which enabled one to determine the unknown x, became the dominant characteristic of science. Facts were the initial step. The experiment as above defined became the sesame to solve certain riddles of the universe.

All these and intermediate stages in the development of science coexist, as do the different stages in the evolution of organisms or of civilizations. The confusion lies in the assumption that the aims, the methods, the mental attitudes, the values of each stage of science are the same. They are no more alike than are the ameba and man, the shepherd age of early Biblical times and the industrial age of 1900. Each stage is real, useful in its sphere, instructive, is a discipline, but they are not equal or alike.

The fact-seeking stage is the amebic stage in the development of science. The law-formulating stage is likewise primitive. The stage of unverifiable facts and laws also belongs to the primitive era of science. The experimental stage, provided it be properly defined, is not only more complex, more modern, but is different from the primitive stages of science. The experimental method, properly defined, characterizes real science and differentiates it from primitive science, from pseudoscience, from non-science, from antiscience.

A few examples may make the meaning more clear. If one describes or catalogues diseases into a nosological system or the species of animals or plants by the rules of classification or the parts of an organism by morphological, histological or embryological rules, one is said to be engaged in science. By the same token the description and cataloguing into a rational system of pigments, lights and brushes would make one an artist. The description and cataloguing of dramas or poems should make one a dramatist or poet. If description and cataloguing of facts into a rational system constitutes science, then the dictionary, the encyclopedia, books of knowledge, outlines of science, survey courses, commercial descriptive catalogues of chemicals, of apparatus, of supplies, of dogs, of dresses, materia medica, hardware or any other body of systematized knowledge—then all these constitute the quintessence of science. Confusion is doubly confounded by including collections of facts in so-called science theses, projects and "researches," from grammar grade to university inclusive.

These collections of facts do not constitute science. At best they are the prelude to science, the building-blocks with which the structure of science is built.

It must not be forgotten that facts and laws are triumphs of a day, reigning to-day, dethroned to-morrow. To-day we believe in Euclidean geometry; to-morrow there is non-Euclidean geometry. To-day it is gravity; to-morrow relativity. To-day we worship calories; to-morrow vitamins and hormones. To-day we enthrone proteins; to-morrow amino acids. To-day we hail the telephone, to-morrow radio. To-day we have found absolute truth in the atom; to-morrow the ion and electron. To-day it is humors and *mal* air, to-morrow it is germs and mosquitoes. Facts and laws and truths change. That which reigns forever is the method of science, the experimental method, true to-day, to-morrow and all time.

It is alleged by many that expertness, or ability to do things resulting from knowledge, is science. Technical ability in making a good slide, or good dissection, a good surgical operation, a chemical analysis, an exercise in physics, constitutes science. By the same logic, the good bricklayer, plumber, builder, artificial flower maker, tailor, gardener, furrier, the butcher, the cook, the surveyor, the cement mixer, the analyzer of sputums and urines, etc., etc., all belong to the brotherhood of science.

It is not my intention to belittle the courses in so-called fact science or to minimize the usefulness of facts, or to detract one iota from the glory of the distinguished men teaching the sciences by this method. It is my intention, however, to point out as clearly as I can, that such courses, such methods represent the earliest, most primitive stages in the dawn of science. To substitute the accumulation of facts and "laws" or dexterity of manipulation for experimental methodology is naïve, erroneous, anti-science, the cartoon of science.

Do you realize how extensively this "fact" and "law" worship dominates our courses in science, not only in high schools, not only in colleges, not only in professional schools of dentistry, medicine, engineering, chemistry, but even in universities? Wherein is the factual method in these science courses different from the factual method in theology, esthetics, literature, art, history, etc.?

I have studied text-books, laboratory directions and laboratory manuals; I have talked with teachers of nearly all grades in all parts of the country, to find out to what extent real, scientific, experimental methodology is used in our laboratories. I find "scientific" dogmas, primitive fact-finding methods, automaton cook-book manipulations, the almost exclusive concentration on facts, more facts and yet more facts. The prevailing method is the archaic or Cambrian stage in the development of science. This archaic devotion to facts and cook-book manipulation parading under the banner of science pervades grammar school to university inclusive.

If time and occasion permitted I would like to cite the innumerable examples from laboratory manuals. In chemistry I can not distinguish any fundamental difference in method from that pursued by my cook in making a new recipe. In physics with elaborate tools for exact measurement I can not distinguish any fundamental difference in method from that pursued by the carpenter, mason, surveyor, builder, auto mechanic, also using tools of precision and following directions at least as intelligently. In biology and many medical courses, the student is told to observe this, that and the other structure, symptom or behavior. The same mental processes are involved as in pre-Darwinian, pre-Galenic days. The terminology and apparatus are different; the method of evaluating evidence is the same. The same emphasis on observation, the same acceptance of facts and theories, the same kind of assumptions concerning causes.

It is conceded that primitive science is a necessary stage in the training process. It is not conceded that primitive methods should occupy all or nearly all the years from grammar school to university.

In what courses of science is the student expected to frame his own question, find suitable materials (including bibliography) and apparatus, devise his own experiment, analyze the conditions, arrange one set of conditions where all are constant or known, another where only one condition or factor is unknown, to vary this unknown *x*, to solve for *x*, *i.e.*, to find the immediate cause of the phenomenon? To determine not facts or laws, but the condition or conditions under which a phenomenon can be made to appear? To get the same results, to deduce proper conclusions from the experimental data, to watch for the crucial exception, so significant as a clue to further resolution of the constituent conditions, to plan the next experiment? Where is it taught that *not facts* or tools or *materials* or *technique*, but the *method of experimental investigation* is the test of scientific procedure?

It is not asserted that all science courses are conducted by the methods of the dark ages. There are beautiful examples of the highest type of experimental courses and investigation. It is asserted that such examples are ominously few. The astounding thing is that so many men, distinguished and honored for the splendid use of the best experimental methods in their own investigations, seem satisfied with the methods of bygone ages so far as the students in their courses are concerned.

One is astounded or amused by the wide use of the terms, the phraseology, the apparatus, the motions, the externalia of experimental procedure in our courses. These but thinly disguise the underlying dogma, cook-book manipulations, unverified or unverifiable conclusions, the methodology of non-science or anti-science. There is far too little of the real spirit of experimental investigation.

I take issue with the one who asserts that the methods of experimental investigation must be postponed to the Ph.D. thesis. I submit that the method can and should be used not only in the Ph.D. thesis, but also in most graduate science courses, in most undergraduate science courses, in most science courses of junior college, high school and grammar school. As a matter of fact, but far too infrequently, one finds splendid examples of true experimental investigation in all these grades of schools.

If it be contended that the spirit is willing but the flesh is weak, that real methods of experimentation can not be taught in classes of 100, 200, 400 and more, where part-time, inadequately and often narrowly trained student and graduate assistants do the teaching, I would agree wholeheartedly with you. If the large numbers of students, crowded schedules of the teachers, etc., prevent true teaching of science, then let it be proclaimed on every hand, on every occasion, let it be clearly understood by all, that what we are teaching is either not science at all or only the lower levels of science. Let it be clearly understood that we are training in modern laboratories, with modern tools and phraseology, by the standards of pre-Galen, pre-Vesalius, pre-Lavoisier, pre-Galileo, pre-Darwin, pre-Bacon, pre-Pasteur.

Maltraining like malnutrition, if long continued, has very serious and lasting effects on the organism—not only upon the large armies of college students but upon the relatively small number of selected (often self-selected) individuals who constitute the professional workers in science. My own experience as editor is in agreement with that of the editors of high exemplars of scientific journals. It is no secret, yet not widely known, how large is the proportion of manuscripts returned to authors not only for minor changes such as clearness of style, form, citations, English, etc., but for major and serious defects, such as inadequate controls, inadequate experimental procedure, inadequate proof that the phenomenon is due to the one variable cited, inadequate or overreaching conclusions from the data submitted. In other words, for lack of understanding of the basic qualities that constitute experimental science. It has been widely urged, and not facetiously, that even more rigid exclusion of manuscripts should be practiced.

Permit me to make brief reference to another related problem. For many years, probably from the time when Latin was the medium of communication by the learned, with increasing nationalism, the rapid specialization of the sciences, the multiplicity of societies, journals and meetings, the rise of science in more and more lands, with corresponding language difficulties, with the barriers created by hosts of new terminologies and elaborate technical procedures, there resulted a series of intellectual barriers that separated the workers into narrower and narrower fields. Such separatism is accentuated in our colleges and universities by the physical separation of departments and subdepartments in different parts of the campus, or, equally effectual, different floors of the same building, and much too frequently by unfriendly doors on the same floor. Each worker or group of workers conducts his researches and courses as though the allied divisions of science were wholly unrelated entities. And inevitably lack of understanding, misunderstanding, duplication, lost motion are correspondingly increased. To be sure, this separatism is not confined to the sciences.

In latter years there have been a number of movements directed to bringing together into cooperative action the workers in allied fields. This section, I believe, was the first among the sections in the American Association for the Advancement of Science to develop and champion such a movement. In 1920 I was honored by election to the secretaryship. During the next seven years, with the closest cooperation of the distinguished members of the section committee, we developed this program. We endeavored to bring together workers in related fields to discuss common and borderline problems. The section committee was selected so that one or more representatives of the different fields of medicine, parasitology, medical entomology, anthropology, vital statistics, veterinary science, medical practice, etc., were members of the committee. The programs were built on the same principle, by careful inquiry of the section committee and others as to the important problems significant to workers in several fields, the outstanding investigators of these problems, the groups that should be invited to cooperate with us to the end that common or borderline problems might be discussed by workers in allied fields. The new policy met with immediate and wide and hearty response.

There were, of course, other efforts by other groups in the same general direction, a breaking down of ever-narrowing barriers, a regrouping and coming together of isolated groups. The Society for Experimental Biology and Medicine has for twenty-six years been bringing together the workers in the manifold fields of experimental medicine and biology. The geneticists are coming together more and more closely each year, and breaking down the artificial walls called zoology, botany, agriculture, etc. The National Academy, the American Philosophical Society, some of the state academies, are but a few illustrations. An interesting example is the union of chemists, physiologists, pathologists and biologists with the surgeons in the Mayo Foundation. The Rockefeller Institute more completely and on a larger scale than ever before (except in war) uses every field, every tool, every facility, and by frequent group meetings attacks the fundamental problems of health and disease. The Carnegie Institution is another illustrious example of coordinated attack on the problems of science. An increasing number of university laboratories, particularly in medical schools as well as industrial laboratories, are being manned and equipped with workers and tools from the allied fields of science. There is a wholesome trend in the same direction in respect to newly organized journals. More and more are the old barriers laid low, regrouping of workers, cooperative use of tools, techniques, cooperation of workers.

In the Cambrian or Precambrian age in which so many of our schools still live, one finds evidences of the ancient separatisms, the old fear of the trespasser, the vicious codes that separate related departments and subdivisions of science, that compel uncorrelated, compartmented, often antagonistic or contradictory facts, methods and results of science.

There are a number of movements making for concerted attacks on important problems by workers in allied fields. There are examples in the drama, in archeology, in exploration, in two or three colleges, in some university laboratories, in many research institutes, in a few grammar and high schools. These are oases surrounded and overwhelmed by the blare of publicity trumpets, proclaiming the polytheism of the sciences, shouting the shibboleths of experiment, project, research, scientific method, integration, survey courses and other fine names for rather poor substitutes of the original article.

When so many ills are believed to be curable not by medicine, but by legislation, we might urge a law like the Food and Drug Act, penalizing institutions of learning which put misleading labels on their wares —a law as unenforceable as many other laws.

May the time come soon when the practitioners of science, individually and collectively as faculties, may more widely and more adequately understand the aims, the methods, the importance of experimental investigation in science, its significance in education, in citizenship. We may then hope that trustees, presidents and heads of government laboratories will cooperate more and more in providing the conditions that will make for better, more thorough methods in teaching science, when emphasis will be transferred increasingly from the search for facts and "laws" to the search for rigorous experimental procedures.

We may then hope for a better understanding of science by larger proportions of our people, expect decreasing influence of faddists and stylists, less opposition and more cooperation from the public that conditions our lives, whether legislature, press, industrial and financial leaders, publicists, medical workers, etc.

We may then hope for a more rapid cure of the ills that the individual and democracy are heir to.

SOME OBSERVATIONS FROM LIMING INVESTIGATIONS[1]

By Professor C. A. MOOERS

TENNESSEE AGRICULTURAL EXPERIMENT STATION

LIMING to increase crop production has been practiced in various parts of the world from time immemorial. The practice, however, appears to have been somewhat intermittent, and in Europe, as well as in this country, many farmers have never limed. The custom of liming gave rise to some disquieting adages, such as "Liming enriches the father but impoverishes the son" and "Lime and marl without manure make both farm and farmer poor."

Soon after the advent of the agricultural experiment stations liming became a subject of investigation. The work of the Pennsylvania and Rhode Island stations is especially worthy of mention. At the latter station, studies were made of the effects of liming on the production of both field and garden crops, and of the relation of liming to different fertilizer materials, especially ammonium sulphate in comparison with sodium nitrate. Later the stations began to investigate the effects of liming on various soil components. Crop yields showed that judicious liming was generally beneficial, but it was essential to learn why this was so. It was also essential to discover harmful effects, if such existed. The solution of the problems involved required long-continued chemical investigations, such as have been pursued for nearly twenty-five years at the Tennessee station. Investigations were begun by the writer in 1905. About 1911 they were in large part—especially those relating to the soil reactions with the mineral elements—entrusted to Dr. W. H. MacIntire, the present head of the department of chemistry. Since that time he and his associates have untiringly, and successfully, pursued laboratory studies on the subject in connection with extensive open-air lysimeter equipments. During the progress of the studies it became necessary, as is often the case, to develop dependable quantitative chemical methods. Of the methods worked out in our laboratories, three have been adopted by the Association of Official Agricultural Chemists. The lysimeters have proved of great value in the determination of the outgo of the different elements over extended periods. The importance of time as a factor is too often overlooked. The forces that produce soil changes, like the mills of the gods, grind slowly. Where the subsoil is retentive, it is only by the use of the shallow lysimeter that the outgo of either nitrogen or the basic elements from the surface soil can be determined quantitatively. This apparently simple matter was not easily established. Precedent required tanks with several feet of subsoil. It was only after a detailed study of several years with lysimeter tanks of varying depths that the need and fundamental importance of the shallow tank was fully realized. This study was begun in the earlier years, and the outgo of nitrates following various manurial treatments furnished the conclusive evidence. In the liming investigations, therefore, two sets of lysimeters were used. One set contained only surface soil; the other contained the same amount of surface soil underlaid with a foot of heavy loam subsoil. The results from the two depths were often dissimilar, for even a foot of such a subsoil materially changes the outgo. The findings, though not always revolutionary, have furnished a substantial foundation on which to base explanations of some of the chemical reactions of the soil and have suggested new viewpoints of more than local interest. This paper deals almost entirely with results from the Tennessee station, but without citation to the more than fifty articles published by the station in bulletins and scientific journals.

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[1] Address of the retiring vice-president and chairman of Section O—Agriculture, American Association for the Advancement of Science, Des Moines, December 28, 1929.

Certain pioneer teachers maintained that liming with burnt lime had a "burning" effect on soil humus. The question has been a subject of field investigation since 1905, and a report from the first twenty years' study has been made. In addition to field plots, cylinders sunk in the ground and lysimeters have been utilized. In the field experiments, liming with burnt lime was found to accelerate materially the outgo of nitrogen and the oxidation of humus for a few years following the application. A retardation of these processes then set in, so that in the course of eight or ten years little difference was found between the humus content of the unlimed and the limed soil. In fact, the only noticeable final effect was where all crops had been removed without either the return of vegetable matter or the production of clover and grass. In such a case the limed areas were slightly lower in both nitrogen and humus.

The study with cylinders placed in the open showed that neither the oxide nor the hydroxide of calcium exercised any determinable chemical disintegration of the humus matter of the soil prior to carbonation or silication, even when heavy applications of eight tons per acre were made. In the case of an application of two tons per acre of burnt lime, maximum carbonation took place within five days and complete silication within ten days. Magnesium carbonate was converted to silicate even more rapidly than calcium carbonate.

One of the discoveries made in the earlier part of the work was the readiness with which silica, a supposedly inert substance, reacted with carbonate of lime—CO_2 being lost and calcium silicate produced. The general conclusion was drawn that the effects of an ordinary liming with burnt lime are derived primarily from silicates. It was concluded that, for soils formed *in situ* under humid conditions, magnesium was almost non-existent except in the silicate form. It was shown also that any toxicity induced by applications of the pulverulent magnesium carbonate was necessarily short-lived. In some of the earlier studies it was found that the silicates of calcium and magnesium produced greater clover crops than their corresponding carbonates—a finding that has since been verified at several other places. Silica additions were successfully used for tobacco as a "buffer" and to eliminate toxicity induced by heavy additions of magnesia.

Soil sulphur, along with soil nitrogen, is an element in plant nutrition that may undergo oxidation, and may, therefore, be influenced by any material modification of the soil reaction or its supply of available calcium or magnesium. The effects of additions of these elements in each of several forms and at widely varying rates were thoroughly investigated over a fifteen-year period. Materially different effects were produced. The light applications of lime in all forms accelerated the outgo of sulphates. The acceleration was the greatest for the first year or two but continued in evidence throughout the period. On the other hand, the very heavy burnt lime applications retarded the outgo, not only through partial sterilization of the soil, but also by a fixation of the sulphate radical derived from both soil and rainwater. Magnesia increased the outgo at all rates of application. The increase was much the greatest at the heavy rates, and under this condition far surpassed that from lime in any form and at any rate. The experiments were carried out with two sets of lysimeters. One set contained about 7 inches of surface soil only, and the other the same amount of surface soil underlaid with a foot of a heavy loam subsoil. For a number of years the amount of sulphates leached from the surface soil alone was very much greater than that which came from the tanks containing the surface soil underlaid with the subsoil. The latter exerted a decidedly retardative effect on the outgo wherever burnt lime was applied. The same was true of the light applications of magnesia but not of the heavy applications, in which case the percolates soon became heavily impregnated with magnesium sulphate. Although the data show that liming increases the outgo of sulphates and that this increased outgo is still apparent after fifteen years, the final outcome can only be surmised. Reasoning from the effects of liming on the nitrogen outgo during twenty years of the cowpea-wheat experiments, there could be expected in the course of time a reduction of outgo due to the diminished supply of oxidizable sulphur. The data obtained are sufficient, however, to warrant the consideration of a possible sulphur shortage for plant nutrient purposes wherever liming is long practiced without sulphur additions from fertilizer or other sources. As a matter of interest and warning it may be stated that the percolation results would have been inconclusive, if not misleading, had not determination been made of the sulphate radical as well as calcium, magnesium and potassium brought by the rainfall.

The findings relative to sulphur as found naturally in the soil were amplified by a similar study for twelve years following additions of ferrous sulphate, pyrite and flour of sulphur. Where ferrous sulphate was applied to the soil, both burnt lime and magnesia increased the outgo of sulphates. Where pyrite was applied, the liming materials tended to depress the outgo. Where elemental sulphur was applied, both burnt lime and magnesia in the lighter applications and magnesia in the heavy applications accelerated the outgo. It is probable that the increased sulphur outgo produced by the liming of a humid soil comes as a result of increased oxidation of organic sulphur.

The literature of the past makes frequent reference to the supposed liberation of soil potash by liming. This appears to have been largely a surmise based on the mass-action effect that was observed when acid soils were suspended in solutions of neutral calcium salts. Plot results were available for each of several widely different types of soil on which liming experiments had been continued from seven to twenty years. The crop yields on the twenty-year field had long shown a greater potash deficiency for the limed areas. It was a question, however, whether this was entirely due to the heavier drafts on the soil potash as a result of the larger crops produced in the earlier years by the liming or in part to reduced availability of the potash. The answer to this question was furnished by the lysimeter studies. It should be stressed that in these studies no crops were grown, hence the quantity of potash in the percolates showed the influence of the various additions of calcic and magnesic materials upon the availability of the soil potash. Ten years ago the Tennessee station published the results from five years of these lysimeter experiments, which showed that in none of the soils used, with a single exception, did liming liberate potash. The exception was where enormous amounts of calcium hydroxide persisted for over two years as the result of 100-ton calcium oxide additions, and even in this case there was only a small and temporary liberation of potash. Ordinary applications of both lime and magnesia repressed the potash content of the soil leachings. The repressive effect of liming upon the solubility of native supplies of potash was likewise observed where potash was added through incorporations of red clover.

The Tennessee station's findings relative to the repressive action of liming on the availability of soil potash have recently been verified by reports from several other stations which showed a lower potash content for plants grown on limed soils. The evidence, as a whole, may be said to show that liming forces potash back into the soil, and not out of the soil as some German investigators have asserted.

The outgo of calcium and magnesium as influenced by different liming materials has been considered in lysimeter experiments for a period of fifteen years. According to the law of mass action it might be expected that calcium would displace magnesium, and *vice versa*, and it was long assumed that this is what took place. The experimental results can be very briefly stated, and are quite at variance with the displacement theory. Liming with burnt lime and high calcic limestone appreciably increased the calcium outgo and depressed the magnesium outgo. In a similar manner applications of magnesium, either as oxide or as carbonate, increased the magnesium outgo and very markedly depressed the calcium outgo. The result from liming with dolomite—a double carbonate of calcium and magnesium—is of special interest. It was found that in spite of calcium enrichment supplied by this material there followed a decreased outgo of calcium and an increased outgo of magnesium. It should be borne in mind that the sum of the enhanced outgo of calcium and magnesium was found to be nearly constant. These findings have an especial interest in explaining the detrimental effect that high-calcic limes may exert upon such a magnesia-loving crop as tobacco. They throw a new light upon many of the interpretations given to the older studies of lime-magnesia ratios.

Study of the accumulated data for calcium and magnesium outgo from economic liming in the lysimeter experiments shows that the loss of lime is too small to account for the decreasing benefit to legumes of high lime requirement. A need for reliming is therefore apparently due to changes in the form or state of the large residual fraction of added lime rather than to extensive outgo in those soils that possess good fixing capacity. It has been demonstrated to our satisfaction that after added lime is absorbed by the soil the absorption product undergoes a progressive decrease in availability. This phenomenon may be a simple "aging," using the term in the chemical sense, for which there are many analogies in the formation of precipitates that in time become increasingly less soluble.

Much has been said relative to base-interchange—a phenomenon that is of great importance in the genesis and subsequent make-up of dyke-reclaimed soils and those of arid regions. Under humid conditions Tennessee soils do not show base-interchange reactions in the zone of incorporation of calcic and magnesic materials, even in the presence of high concentrations of a neutral calcium or magnesium salt; but on the contrary they show a repressive action. On the other hand, the percolates from lime- or magnesia-treated surface soil do exert a base-interchange effect in the subsoil where the action of sulphates, nitrates and chlorides comes into play beyond the zone of contact between the soil and additions.

The writer has reserved for the close of this paper a brief discussion of a most interesting and important soil reaction which explains certain soil phenomena and also has other and unexpected applications as an important analytical procedure both in the soils laboratory and in industry. That is the formation of the ternary systems, $CaO-Fe_2O_3-CaSO_4$ and $CaO-Al_2O_3-CaSO_4$. These compounds and the reactions involved were new to soil chemistry, and their discovery is one of the more interesting achievements of the station's researches.

In connection with certain lysimeter experiments it was observed that very heavy liming—100 tons of CaO per acre—practically inhibited the outgo of sulphates for a year or two, but that this effect was not permanent. The phenomenon was studied from various angles, and finally by means of a synthetic study with pure gels, the formation of compounds of both iron and aluminum united with CaO and $CaSO_4$ was found to be the explanation. These compounds are of low solubility as long as the system is alkaline, but are readily soluble in either neutral or acid media. Further investigation showed that aqueous solution of calcium hydroxide and calcium sulphate readily attacked aluminum complexes in the soil, with the formation of the ternary compound. Afterward the reaction was utilized as the basis of a chemical method of determining the amount of reactive alumina and silica and promises much as a useful yardstick in the measurement of the colloidal properties of a soil. Industrially the discovery is valuable because an explanation is given for the disintegration of concrete under certain conditions, which had previously not been understood, and furnishes the necessary information for the avoidance of such trouble in the future.

In conclusion, the fact may well be emphasized that the soil solution is the source of all the nutrients taken up by the roots of plants. As Brazeale has said, "The plant deals with the soil solution and with the soil solution only." It is this solution that is obtained by means of lysimeters. Lysimeter findings may therefore be studied to advantage by plant physiologists and others who are interested in learning what effects manurial treatments may be expected to exert upon crop-nutrient assimilation and plant-ash content.

A DEVELOPING VIEW-POINT IN OCEANOGRAPHY

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At the Princeton meeting of the National Academy of Sciences on November 18 last, its committee on oceanography, consisting of W. Bowie, E. G. Conklin, B. M. Duggar, J. C. Merriam, T. W. Vaughan and F. R. Lillie (*chairman*), with H. B. Bigelow, *secretary*, submitted a report on its study of the scope, economic importance and present status of oceanography, with recommendations as to how this science may more effectively be encouraged in America. To the general scientific public the most significant feature of the report is perhaps the general conclusion, reached by the committee, that the establishment on our Atlantic coast of a new organization dedicated to the encouragement and prosecution of oceanographic investigation is "the greatest need at the present time, both from the point of view of American oceanography and also for adequate participation of this country in a study necessarily international." The committee concludes further that "the establishment and endowment of an Atlantic Oceanographic Institute should be realized at the earliest possible moment."

The report is too long to be summarized here.[1] We, therefore, think it pertinent to set forth something of the view-point developed in the report that led to the recommendation of this particular kind of support for oceanography, rather than to the more conventional suggestion that our knowledge of the sea would be most rapidly increased by more deep-sea expeditions, and greater.

This commitment implies, as is indeed the fact, that oceanography has of late entered a new intellectual phase, to explain which a word of retrospect is necessary. While in one sense this is among the oldest of natural sciences, in another it is one of the youngest. To date its absolute birth is an impossibility, for this took place when first some fact about the sea was not only observed but recorded: certainly this happened many centuries before the Christian era. And with the passage of the centuries recorded knowledge continued to accumulate about one phase or another of what we now call oceanography. But this could hardly have been dignified with the rank of a separate science down to the early years of the century just passed, because it had not yet passed the stage of collecting and recording isolated facts, whether about the surface of the sea, about its inhabitants in shallow waters or about its margins. In fact all that lay below the surface of the open sea, or more than a few fathoms down from tide-line around its shores, continued, down to the late seventeen hundreds, as much a mystery as it had been to the Phenicians, except when some deep-sea fish was cast up upon the strand. Indeed, it was not until about the middle of the nineteenth century that systematic examination even of the surface of the sea was seriously undertaken, or that scientists awoke to the fact that the underlying waters offered a whole new world for exploration, that offered no unsurmountable difficulty.

Evidently this descent into the abyss could not be made without the development of suitable instruments, whether to plumb the depth, to sample the living creatures there or to measure the physical and chemical characteristics of the water. And philosophically it is interesting that it was the birth of this new view-point, reached from gleanings with very primitive gear during the preceding fifty years or so, which led to the development of efficient instruments—not the reverse.

It would, indeed, have been quite within the technical abilities of the Romans of Pliny's day to develop the depths of the Mediterranean and to explore its biota, though of course examination of the temperature and salinities of the sea must in any case have awaited the development of the sciences of physics and chemistry as we now know them.

Students of the history of science may well date the birth of modern oceanography from December 21, 1872, the day when the *Challenger* set sail from Portsmouth, England, on her memorable voyage. And thenceforth, with every fresh venture below the surface of the sea, such a flood of new facts came pouring in that it seemed for a time as though this fact-catching could never lose its novelty. One great deep-sea expedition led to another, and more was learned about the sea during the last thirty years of the nineteenth century than had been during the preceding three thousand. But after a time, as so often happens when some scientific discipline takes a sudden spurt, this fact-catching began to lose something of its freshness.

At first, when no one knew what lived on the bottom of the sea, every new fish that was drawn up was a marvel. But now we have come to have a more sophisticated outlook upon such things. Students began, in short, to feel that the mere accumulation of facts from the sea, when there is an inexhaustible supply, may actually become a bit sterile, just as catching fish is to a sportsman where fish are too plentiful. To maintain interest under such circumstances, one must need the fact—or the fish, as the case may be. So it was natural that when persistence in the old methods no longer yielded startling discoveries, signs could be seen of the approach of a period of stagnation, following the peak of fevered activity. And oceanography would probably be in a moribund state in America to-day, just as the art of sailing a square-rigger is, but for the birth of the new idea that what is really interesting in sea science is the fitting of these facts together, and that enough facts had accumulated to make the time ripe for an attempt to lift the veil that had obscured (and still obscures) any real understanding of the marvelously complex and equally marvelously regulated cycle of events that takes place within the sea.

The foundation for this conscious alteration in view-point, from the descriptive to the explanatory, was a growing realization (this could have come only after multitudes of facts had been accumulated) that in the further development of sea science the keynote must be physical, chemical and biological unity, not diversity, for everything that takes place in the sea within the realm of any one of these artificially divorced sciences impinges upon all the rest of them. In a word, until new vistas develop, we believe that our ventures in oceanography will be most profitable if we regard the sea as dynamic, not as something static, and if we focus our attention on the cycle of life and energy as a whole in the sea, instead of confining our individual outlook to one or another restricted phase, whether it be biologic, physical, chemical or geologic. This applies to every oceanographer: every one of us, if he is to draw the veil backward at all, must think and work in several disciplines. He must be either something of a Jack of all trades or so closely in tune with colleagues working in other disciplines that all can pull together.

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[1] It is now available in mimeographic form.

We see here a case where economic pressure was largely responsible for lifting a field of knowledge, willy-nilly, to a higher and more rarefied atmosphere of what we flatter ourselves by calling "pure science"—in this instance the plight of the commercial sea-fisheries of northern Europe. The countries bordering on the North Sea had exploited the resources of the fisheries for centuries. And it chanced that just when oceanography was enjoying its nineteenth century boom, the fisheries were also so rapidly expanding in intensity, through the development of more effective fishing methods, that the dread of overfishing became imminent. What more natural than for the maritime nations to turn for advice to the sea scientists who had for the past fifty years been so busily carrying on explorations of the sea, naming and classifying the fishes—especially when the deep-sea expeditions had been so largely supported by taxpayers' money?

But sound advice as to the wise management of the fisheries science could not give, for while volumes of facts had been garnered about the individual species of food-fishes, and as many more about the medium in which these live, there had as yet been no general and concerted attempt to fit these two categories of facts together, or in other words, to unravel the skein of factors that controls the lives of fishes in the sea. It was, however, clear enough, once attention was directed thereto, that if the exploitation of the deep-sea fisheries was to be based on sound, rather than on hit-or-miss, principles of conservation, it demanded just this understanding of the lives of its victims; it was equally clear that such an understanding could be gained only through a synthesis of studies in many fields, and that no mere piling up of data, however extensive, could yield it.

All this was so obvious, once pointed out, and the economic urge was so pressing that a vast amount of attention (and a vast amount of money) has been expended on fisheries-biology during the past quarter century, and an appreciation of the need of unity has come to permeate the whole edifice of oceanography. But even with this new view-point and new impetus, science has given assistance much more slowly to the suppliant fisheries than had been hoped, because the requisite synthesis of knowledge has proved a task immensely difficult intellectually as well as technically, and because we are only now beginning to appreciate the appalling complexity of every marine problem—a complexity which if discouraging in one way offers in another way a most alluring stimulus. Speaking as a biologist, the proverbial "way of a maid with a man" is glass-clear as compared with the way of a fish in the sea, for in the sea there is no such thing as a hermit fish—or fact: every sea animal depends on an endless chain of other animals or plants and equally on an endless chain of facts and events in its inanimate surroundings.

Though we have been studying cod, mackerel, lobsters and the rest, with men and ships at sea, in libraries and laboratories ashore, with hopes and with discouragements, for all these years, we do not yet know all the links in the life chain of any single species, or even which links are apt to be the most important, or even where to seek more than a few of these links. But oceanographers do now very thoroughly appreciate that the geophysical and chemical links are quite as vital—perhaps even more so—than those of the sort more usually named biologic.

When one picks up a fish, one may be said, allegorically, to hold one of the knots in an endless web of netting of which the countless other knots represent other facts, whether of marine chemistry, physics or geology, or other animals or plants. And just as one can not make a fish-net until one has tied all the knots in their proper positions, so one can not hope to comprehend this web until one can see its internodes in their true relationship. This is to-day the conscious aim of oceanographers.

To look more closely at some of the lines of knots in the web will perhaps help to bring this conception home.

On the whole, the simplest of these to follow, and certainly among the most important, are the food lines, *via* which one species is interdependent upon another. Thus a shark may eat a pollock, a pollock may eat a smelt, a smelt eat an amphipod, an amphipod eat a copepod and a copepod eat a diatom, and each must find its food-species at hand or perish. Or followed in the reverse description, we see here, as clearly, an enemy-prey line, for amphipods, if plentiful enough, may locally exterminate copepods, or fish locally decimate amphipods. And big fish may so prey upon little ones (even of their own species) that this last factor must seriously be taken into consideration in studying the maintenance of stocks of fishes on certain of our most productive fishing banks, for there is no prejudice against cannibalism in the sea; that is a purely terrestrial invention.

Nor can the biologist focus narrowly upon the biologic lines in this allegoric web, the chemist on the chemical, for when any animal is hatched into the sea and throughout its life, its survival depends quite as much upon whether its physical and chemical surroundings are favorable as upon the immediate food supply, or presence of enemies; while in life and in death marine organisms profoundly affect their aqueous environment. This interdependence, by and large, is much more intimate in sea than on land, for reasons that there is not space to enter upon here. Marine animals and plants being, as a class, much less effectively protected against their environment (because the marine aquatic environment is a favorable one, not an unfavorable, as is the air), the balance in this respect is often a very delicate one indeed. For examples of this, one need only turn to the tremendous fluctuations that are known to take place from year to year and over periods of years in the numerical abundance of various fishes in the sea, from purely natural causes with which the hand of man has had nothing whatever to do. It will be enough here to refer to the proverbial ups and downs shown by the mackerel. In the eighties of the past century American waters swarmed with mackerel: the sea was full of them. They then dwindled in abundance (though with ups and downs) until, at their low point, in about 1910, the mackerel might almost be called a scarce fish. But then the stock began to build up again, in spite of the fishery, until to-day it seems that we may look forward to another period of tremendous plenty in the near future. Annual fluctuations, almost equally spectacular, are well known to have taken place among the herring and among many other species.

We now realize that these periods of plenty and of scarcity in essence reflect good and poor years of production; that for many fishes a year of good production is decidedly an unusual event, so that a given year-class may dominate the stock over a considerable term of years, whereas other species may maintain a more nearly even population. And we begin to be able to predict, from the number of young fish produced and surviving in a given year, the probable productivity of the fishery in years to come. But we are still totally in the dark as to the exact causes of such fluctuations, except that they certainly are not inherent in the vital nature of the species concerned but have to do with external circumstances, or events, in the end physical-chemical.

The most obvious line of connection between the biological and the physical-chemical realms in the sea is *via* temperature; no creature can live, much less thrive, if the water be too hot or too cold. But even as seemingly simple a constant as temperature can not be considered *per se*, or as an adjunct, in the sea, because water has no inherent temperature, but is given the latter by a complex of such factors as solar radiation, back-radiation to the air, evaporation and the melting of ice. Consequently, in our examination of temperature, we are led without a break into the fields of astrophysics, of meteorology and of polar geography. We are also led, very abruptly, to a consideration of the circulation of the sea, because the temperature there at any given time and locality is largely controlled by the currents, as the latter transfer cool or warm water-masses from place to place. There is, too, a direct mechanical connection between ocean circulation and the lives of the marine inhabitants quite as important as that *via* temperature, for currents also carry plants and animals about, likewise other materials of all sorts. Currents, in fact, play much the same rôle in marine economy as do railroads, or any other transportation system on land.

We must realize that, wonderful medium though sea water be for the support of life, any animal or plant would soon exhaust the vital possibilities of the water in its immediate vicinity unless some transportation system were in operation, either to carry the creature elsewhere (whether voluntarily by its own activity, or involuntarily) or to bring to it new water holding in solution or in suspension the substances that the organism in question needs. For the latter sort of transport, the currents and drifts of the sea are wholly responsible; largely so also for the former, by effecting the involuntary migrations of creatures young and old, a kind of dispersal that is constantly going on, and on a scale much broader than is generally appreciated. If the life of the eel is perhaps the most spectacular instance of this type of migration that has yet been followed through to its conclusion, thousands of other kinds of sea animals and plants equally owe their geographic distribution (presence here and absence there), and their dispersal from the regions where they were produced to other regions where they pass the greater part of their lives, directly and solely to mechanical transport by ocean currents. This category of travelers includes the majority of our important food fishes, for most of these, when young, drift at the mercy of tide and current for considerable periods. We think here not only of thousand-mile migrations such as those of the young eel but also of shorter travels such as those of the codfish, by which the little fry are dispersed from the inshore grounds of their nativity to offshore banks, where they grow and fatten for the nets or hooks of the fishermen, and of similar events in the lives of the haddock, of the herring, of the mackerel, of the plaice and of a host of others.

In our allegorical web of the sea, the current-lines also lead in many other directions. Currents of a sort not so familiar (*i.e.*, vertical) are solely responsible, for example, for the aeration of the deeps, without which all but the uppermost stratum would be a waste more desert than the Sahara. Currents, too, largely control the distribution of salinity over the oceans; they wear down some coast lines and build up others; they distribute sediments over the bottom of the sea; they affect indirectly and directly the comings and goings of every seaman who sails the sea, and they so largely determine the climates of the continents and the system of winds that there is no possible way to disentangle oceanography from climatology.

Reasons as cogent as these make even the biologist admit, no matter how strictly he may confine himself to his own narrow niche, that the currents of the sea offer to-day one of the most intriguing fields of study in sea science. And this is true not only from the descriptive side (for we still have much to learn even about the characteristics of the larger and more impressive ocean currents—Gulf Stream, for instance—let alone the obscure) but from the standpoint of the physical forces that keep the circulation of the sea in its closed and continuous operation. So the unfortunate biologist, even if mathematics are to him a closed book, as is the case with too many of us, must perforce take as keen an interest as do his physical confrères, and hold as high an appreciation of the modern applications of mathematics to oceanic dynamics.

The interrelations between the chemical and the biological phases of oceanography are quite as close as those just mentioned, again, perhaps most easily illustrated *via* the food-line. Even the tiniest animal in the sea must have organic stuff on which to feed. And we have been in the habit of thinking that sea-animals, like land, must depend in the long run on green plants for their pastures. Perhaps this is not an invariable rule, for it is possible that the autotrophic bacteria may prove to short-circuit this line more generally than now seems likely. But in the main, animal life in the sea does depend for its existence on the ordinary marine plants, chiefly on the planktonic plants. The problem of the food supply of these plants falls directly within the province of the chemist, for the only sources for plant food in the sea are the substances dissolved in the surrounding water. Consequently the biologist is as intimately concerned with the sea water itself as is the geochemist. Whether for the one or for the other, most of the basic problems of oceanography focus around the fact that the oceans are filled not merely with water, but with water that is "salt."

Though sea water may be named the most complex of all common substances if judged by the number of its constituents (for doubtless it contains, in solution, all the known elements), it is on the other hand the most uniform of all common substances, next to air, as measured by chemical analyses of ordinary delicacy: Sea water is sea water from whatever ocean we may draw it. And one of our most interesting oceanic problems of to-day is how this uniformity is maintained against the great variety of processes that are constantly working to destroy it. Here, again, the disciplines of the biologist, of the geochemist and of the geophysicist unavoidably unite, for some of these processes belong in one, some in another of these scientific subdivisions.

This is self-evident; for example, the diluting effect of the rain that falls upon the surface of the sea or of the fresh water that is poured in by rivers, and the concentrating effect of evaporation, all offer problems in physics. Consider, again, the chemical problems that center around the fact that the solutes contributed with river water are very different in their compositions from sea salts; around the withdrawals of lime, of silica, even of strontium by animals and plants in the formation of their shells; equally around the withdrawals of food stuffs by plants, balanced against the contributions to the water of other stuffs as carcasses decay; or around the alterations in ionic dissociation that result from such additions and withdrawals. Only in conjunction can chemist, geologist or biologist hope to learn how the sea remains so constant through it all that we must analyze to parts per million, even to parts per thousand million, before we can express the existing variations in the relative proportions of its different salts; or how it is that the alkalinity of the sea never varies outside the narrow range in which protoplasm can live—is in fact as delicately balanced as the alkalinity of our own blood serum. It is only by a synthesis far more thorough than has ever yet been accomplished that we can ever hope to understand the working of the marvelous and self-operating regulatory system that maintains this balance now and that we may be sure has maintained it through past geologic ages.

From whatever point in our allegorical web we may choose to commence, whether geophysical, chemical or biologic, if we proceed far enough in our exploration we are inevitably led into the province of the geologist (and *vice versa*), for the oceanographer, if he is to be anything of an architect (not a mere bricklayer) must equally concern himself with the shapes and with the structure of the basins that hold the oceans.

As truly as the character of the bottom of the sea largely determines what kinds of animals live thereon (which every fisherman knows to be the case), biological processes going on within the water as largely determine what sorts of sediments shall accumulate in any given place to make up this bottom, except around the coasts, where these processes are masked by silt washed down from the land. Consequently the problems of sedimentation in the ocean fall as much within the province of the biologist as of the geologist. Thus the oozes that accumulate over the greater part of the sea floor consist of the skeletons of animals and plants that sift down after death from the upper layers.

Where, when and in what quantity these skeletons start to sift down is a problem as strictly biologic as any, for it depends in part on the geographic distribution, equally on the birth and death rate of the particular plants and animals concerned. But whether and in what quantities these skeletons do actually reach the bottom is a physical-chemical question, as is the ultimate fate of such of them as do arrive there. So, too, is their effect upon the bottom water of the ocean when they go back into solution, for given time enough anything will dissolve in normal sea water. But at the same time, the alterations caused in the sediments by the entrapped water offer very important and far-reaching geological problems, for while we know that the limestone and shale rocks were originally laid down under the water under conditions comparable to those of to-day, they differ greatly in their present state from the muds and oozes that are now accumulating under the seas. Two of the most pressing problems in this field concern the method of formation of petroleum and of iron ores. In fact, no one will dispute that the study of the modern sea bottom is a geologic necessity, for only by this means can geologists hope to understand how the different classes of sediments now solidified into rock were originally accumulated and subsequently metamorphosed.

The shapes of the oceans, too, confront the oceanographer at every step, whatever be his particular chosen field of research, because it is the contours of the coast lines and of the submarine slopes that confine and control the whole system of submarine circulation, however it may be kept in motion. And as every oceanographer realizes, this circulation is in the end the life blood of all the events that take place in the sea.

There is, I think, no need to quote more examples to show that the different disciplines of oceanography inevitably interlock, or to prove the intellectual necessity of not only recognizing but indeed acting upon this unity, if we hope ever to gain a thorough understanding of the sea and its inhabitants. Any attempt (conscious or unconscious) to hold them apart can result only in frustrating this high aim and in setting us backward to the stage of simply gathering and accumulating facts in unrelated categories.

OBITUARY

WILLIAM A. ORTON

DR. WILLIAM A. ORTON, scientific director and general manager of the Tropical Plant Research Foundation for the past five years, and formerly senior pathologist in charge of the office of cotton, truck and forage crop disease investigations at the Bureau of Plant Industry, U. S. Department of Agriculture, died at his home in Takoma Park, D. C., on January 7. He was in his fifty-third year, having served slightly more than twenty-five years in the department at the time he resigned to take up the tropical research work. Funeral services were conducted at the Takoma Park Presbyterian Church on January 9, and interment was in Rock Creek Cemetery, D. C.

The death of Dr. Orton closed a brilliant career, one marked during its later years by a courageous struggle against ill health which was a marvel to his associates. In spite of these limitations, he was a leader in the field of plant pathology and tropical agriculture, and has accomplished results of outstanding importance in the thirty years since he entered the Department of Agriculture.

Dr. Orton was born on February 28, 1877, at North Fairfax, Vermont, and was graduated from the University of Vermont with the B.S. degree in 1897. After a year of graduate work in the University of Vermont, specializing in botany and plant pathology, he received his M.S. degree in 1898. In 1915 the degree of D.Sc. was conferred upon him by the University of Vermont. He entered the Department of Agriculture on June 1, 1899, two years before the establishment of the Bureau of Plant Industry, and was prominently associated in a constructive way with the activities of the department, particularly in lines related to plant pathology, for a little more than a quarter of a century.

During the first decade of his service in the U. S. Department of Agriculture he carried on researches on diseases which were causing serious losses to cotton, cowpeas and watermelons in the southern states, and he was a pioneer in the work of breeding and selection which resulted in the development of disease-resistant varieties that have been such great factors in reducing wilt and root-knot losses in these crops.

In 1907, soon after the organization of the Bureau of Plant Industry, he was made head of the office of cotton, truck and forage crop disease investigations, and held that position continuously until he resigned from the department in November, 1924. During this period the work under his charge gradually grew until it included research projects on the diseases of most of the important vegetable and forage crops. Potato diseases especially received major attention and largely as a result of work done under his direction the infectious nature of the numerous virus diseases of potatoes was discovered and methods of control through the use of certified seed were worked out. Dr. Orton was instrumental in initiating and promoting the now accepted methods of potato seed certification which have been of enormous value to the potato industry of this country.

Dr. Orton organized and for several years carried on the plant disease survey of the Bureau of Plant Industry, which has become of great importance in connection with work on the control of crop diseases. During the World War he was active in organizing research work on diseases causing losses of vegetables in transit, market and storage, which was developed in close cooperation with the food products inspection service of the Bureau of Agricultural Economics and very materially increased knowledge of the causes of losses in shipment and marketing. As a result of this work methods for the reduction of disease losses in the process of marketing have been developed.

He was also active in the work leading up to the passing of the plant quarantine act, and for the last twelve years of his departmental service he was vice-chairman of the Federal Horticultural Board.

In addition to his plant pathology investigations, Dr. Orton privately carried on studies of food plants with a view to providing a more varied and suitable diet for invalids, especially diabetics and neurotics, whose range of foods is restricted.

He was very active in the organization of the American Phytopathological Society. He was its president in 1921, and for several years editor-in-chief of its official journal, *Phytopathology*. Also he was a charter member of the American Horticultural Society organized in 1922 and a member of the following scientific societies and clubs: The American Association for the Advancement of Science, the Botanical Society of America, the Botanical Society of Washington, the Washington Academy of Science, the Society of Horticultural Science, the American Society of Agronomy, the American Genetics Association, the American Society of Naturalists, the International Society of Soil Science, the Société de Pathologie Végétal, the Society of Foresters, International Society of Sugar Cane Technologists, the World Agricultural Society, the Cosmos Club and Phi Beta Kappa.

In November, 1924, he resigned from the department to become scientific director and general manager of the Tropical Plant Research Foundation, an organization initiated by a committee of the National Research Council, of which he was chairman, for the purpose of promoting the study of the plants and crops of the tropics and their disease and insect enemies. The principal projects under way are those on sugar-cane production problems in Cuba with the support of the Cuba Sugar Club; a survey of sugar-cane and cotton industries of the west coast of Peru; an investigation of chicle production problems of British Honduras, a forestry survey of portions of Cuba and a survey of the timbers of tropical America. He was also technical adviser to the division of agricultural cooperation of the Pan American Union. In connection with the establishment and carrying on of this work of the foundation Dr. Orton made numerous trips to Cuba and one trip to Brazil in the interest of the development of a national forest service in the Brazilian Department of Agriculture.

The Inter-American Conference on Agriculture, Forestry and Animal Industry, which is to be held in Washington in September, 1930, under the auspices of the Pan American Union, grew out of recommendations which were presented by Dr. Orton through the Pan American Union to the sixth International Conference of American States, which met at Havana in 1928. He has worked actively in the preparation of the program which will be followed at this conference.

Dr. Orton was a man of unusually broad vision and clear judgment as to the needs of agricultural science in the United States and tropical America. Coupled with this was outstanding, original ability in the formulation of sound workable plans for the accomplishment of desired results. He recognized the value of cooperation for the attainment of scientific results, and had the personality to make and keep friends, so essential in such an undertaking. His influence on young men entering the field of scientific endeavor has been outstanding, and has left with them lasting inspiration. He was always kindly and considerate of others, of even temperament and easy to work with and his optimism was unbounded. His acquaintance was broad and his friends are many.

Dr. Orton's publications, largely on subjects related to plant pathology, comprise some forty or more bulletins and circulars of the Department of Agriculture and many published in outside journals and magazines and by the Tropical Plant Research Foundation.

Dr. Orton is survived by his widow and two daughters, Alberta and Alice, and by two married sisters, who reside in Vermont.

W. W. GILBERT

SCIENTIFIC EVENTS

SINANTHROPUS PEKINENSIS

THE Peking correspondent of the London *Times* reports that at an open meeting of the Geological Society of China held on December 28 the closely guarded details of the finding in North China of the skull of a man hundreds of thousands of years old were officially revealed. The discovery, which is claimed to be the most important of its kind, was made on December 2, in a limestone cave deposit at Choukoutien, forty miles from Peking.

The find is said to be a unique specimen, and consists of the greater part of an uncrushed adult skull belonging to an entirely new genus, known to science as *Sinanthropus Pekinensis,* which is definitely placed above the Java ape-man in brain capacity, but below Neanderthal man. The Peking man is considered to antedate Neanderthal man and is held to be nearer the genus *Homo* than the Piltdown and Java types. Estimates of the age of the skull vary greatly. Dr. Grabau, adviser to the Chinese Geological Survey, states that the Peking man lived at the beginning of the Quaternary Period and gives his age as 1,000,000 years, but Père Teilhard Dechardin, president of the Geological Society of France, and also adviser to the Chinese Survey, favors an estimate of 400,000 to 500,000 years.

The credit for the actual discovery of the skull goes to a young Chinese geologist, Mr. W. C. Pei, in charge of the field work of the Geological Survey at Choukoutien last season. Excavations there had previously yielded the major parts of the two lower jaws and numerous teeth and skull fragments of "Peking Man," as well as four tons of fossil remains, including the sabre-toothed tiger, which flourished at the same time as "Peking Man." The skull is still largely embedded in hard travertine, which will require a couple of months of difficult and delicate work to remove, but the vault from the massive brow ridges to the occiput and the whole of the right side have already been freed from the relatively soft matrix, showing that while most of the facial region seems lacking, the brain case is almost completely preserved. The massive jaw sockets are also visible.

Compared with the Java skull which is approximately the same length, the Peking skull is said to possess characteristics which point to relatively greater brain capacity.

CANADIAN NATIONAL RESEARCH LABORATORIES[1]

TENDERS have been invited by the Government of Canada for the construction of a National Research Laboratories building that will cost, when finished, approximately three million dollars. Appointments of chiefs to two of the laboratory divisions has been announced.

Dr. H. M. Tory, formerly president of the University of Alberta, and now the president of the National Research Council, has expressed the view publicly that the new home for research in Canada will be one of the finest to be found in any country. It is being built on the banks of the Ottawa River in the capital city. Designed in the form of a giant figure "8," it will stand 60 feet (four stories) high, 418 feet long, and 176 feet deep. Two hundred and fifty thousand feet of floor space will be provided. Library accommodation will be for 300,000 volumes. An assembly hall and associated rooms will be capable of accommodating the staff and the various scientific societies of the Dominion.

Plans call for the development of the following divisions: The divisions of physics and engineering physics, to the head of which Dr. Robert William Boyle, dean of the faculty of applied science at the University of Alberta, has already been appointed; the division of industrial chemistry, to the head of which Dr. George Stafford Whitby, professor of organic chemistry at McGill University, has been appointed; the division of economic biology and agriculture, to which Dr. Robert Newton, professor of field crops and plant biochemistry at the University of Alberta, is the acting head; the division of industrial engineering, the division of textiles, the division of standards, and such other divisions as improvement in industrial processes, the development of natural resources, and the utilization of waste require.

Dr. Boyle was graduated from McGill University in 1906, and from then until 1909, when he received the Ph.D. degree and the 1851 scholarship, he did research on the properties of matter and radioactivity. From 1909 until 1911 he continued his work under the direction of Sir Ernest Rutherford at the University of Manchester. Returning to Canada, he lectured at McGill, was appointed assistant professor in 1912, and in the same year was made professor in the University of Alberta. During the war years, on the recommendation of Sir Ernest Rutherford, Dr. Boyle was engaged in research for the Admiralty Board of Invention and the Anti-submarine Division; and in that work he developed important applications of ultrasonics. In 1924 he tested apparatus for the detecting of icebergs and the sounding of depths in the Belle Isle Straits.

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[1] From *Nature.*

Dr. Whitby studied chemistry under Sir William Tilden at the Imperial College of Science and Technology, London, graduating in 1906 with the Frank Hatton prize. He was one of the first scientific workers to study the rubber industry, and one of his books thereon, "Plantation Rubber and the Testing of Rubber," 1920, has markedly influenced the trend of rubber research. In recognition of his contribution in that field, the Institution of the Rubber Industry (Great Britain) recently awarded him the Colwyn gold medal. In 1928 the distinction of Officier d'Académie was conferred upon him by the Government of France. The same year he was president of the Canadian Chemical Association.

As assistant director of the division of physics and engineering physics, Prof. John Hamilton Parkin, associate professor of mechanical engineering at the University of Toronto, has been appointed to direct the development of national aeronautical research laboratories.

Plans for the new National Laboratories building call for completion early in 1931. Meanwhile, temporary laboratory space has been provided.

THE AMERICAN STANDARDS ASSOCIATION

Announcement that the underwriting of the finances of the American Standards Association for a period of three years to permit a total annual expenditure of $150,000 for its work is now being completed has just been made by William J. Serrill, president of the association. This fund permits an increase in the budget for 1930 of $80,000 over the previous budget of the association and is expected to result in an expansion of national standardization work affecting practically all industries.

The fund is being underwritten by a large group of industrial organizations. The underwriting was arranged by a committee consisting of James A. Farrell, president of the United States Steel Corporation; Gerard Swope, president of the General Electric Company; George B. Cortelyou, president of the Consolidated Gas Company of New York, and F. A. Merrick, president of the Westinghouse Electric and Manufacturing Company.

Because of the rapid growth of the industrial standardization movement in this country, the underwriting was planned to permit immediate expansion of the work of providing authoritative national standards while permanent financing is under way. It is expected that this financing will be completed during the three-year period of the underwriting.

Among the companies joining in the underwriting are:

Aluminum Company of America
American Telephone and Telegraph Company
Bethlehem Steel Company
Consolidated Gas Company of New York
Detroit Edison Company
General Electric Company
General Motors Corporation
Gulf Oil Corporation of Pennsylvania
Public Service Corporation of New Jersey
Standard Oil Company of New Jersey
U. S. Steel Corporation
Westinghouse Electric and Manufacturing Company
Youngstown Sheet and Tube Company

Up to the present time the association has adopted approximately 160 national standards, and 190 other national standards are being formulated. The association provides the machinery by which all of the producing, distributing and consuming groups concerned with a standard may cooperate in its preparation. The foremost technicians of all groups are thus brought together to pool their knowledge for the benefit of all. Over 2,000 individuals representing 800 cooperating organizations are in this way working on technical committees under the procedure of the association.

An important feature of the association's work is the adoption of national standard safety codes, which are used voluntarily by industries and also as the basis for state and municipal safety regulations and for the regulations of insurance companies in numerous states. Among the most important of these codes are the National Electrical Safety Code, the Code for Mechanical Power Transmission and several codes for mine safety.

As the result of the recent affiliation of the American Home Economics Association with the American Standards Association, this latter body has also begun important standardization work on projects of direct concern to the ultimate consumer, such as refrigerators, sheets and blankets.

INTERNATIONAL CRITICAL TABLES

The sixth volume of the International Critical Tables was issued about the middle of October. The permanent secretary of the National Research Council reports that most of the material for the seventh volume is now in type. It is not possible, however, to say when this volume will be ready for distribution for the reason that this, being the final volume of the series, will contain the general index, which will probably require several months for its preparation, since it is to appear in four languages, and much time must be allowed for translation and attendant correspondence in its compilation.

However, the Council is now in the final stage of this undertaking, the editorial work on which began in the summer of 1922, and the collection of funds two years earlier. Altogether about $205,000 has been contributed by industrial corporations and philanthropic organizations toward the editorial work of the tables. Royalties on the five volumes published prior to this fall amounting to $45,078.75 have been received and applied to the editorial expenses. With the receipt of royalties on the later volumes the remaining editorial work can be fully provided for. Together with interest received on funds temporarily invested and from other miscellaneous sources a total sum of about $235,000 will have been expended through a period of eight years on the editorial preparation of these tables. The total number of subscriptions to the tables at the prepublication rate of $7 per volume is about 6,700, and at the regular price of $12 per volume about 400. The total number of paid-up subscribers in both classes for the first five volumes of the series is about 6,300. Of these about 5,000 have subscribed for Volumes VI and VII.

The Council of the National Academy has approved the appointment of the committee recommended at the last meeting of the executive board to pass upon requests to reproduce material from the tables. This committee consists of the editor-in-chief of the tables, the permanent secretary of the council, and the chairmen of the council's divisions of physical sciences, and of chemistry and chemical technology.

RECENT APPOINTMENTS AT THE MELLON INSTITUTE

DR. E. R. WEIDLEIN, director of Mellon Institute of Industrial Research, Pittsburgh, Pennsylvania, has announced the following appointments at that institution made between July 1, 1929, and January 1, 1930. The appointments for the first half of 1929 appeared in the August 2 number of SCIENCE on page 115.

Senior industrial fellow:

James N. Lawrence, Ph.D. (Wisconsin, '12), has been appointed to the senior incumbency of the multiple industrial fellowship on wax. He succeeds Dr. D. K. Tressler, who has joined the research staff of the General Foods Company, Gloucester, Massachusetts.

Industrial fellows:

Henry A. Ambrose, Ph.D. (Mass. Inst. Tech., '30), has been appointed an industrial fellow on the multiple fellowship on petroleum production.

N. J. Beaber, Ph.D. (Iowa State College, '25), has been appointed to the nicotine fellowship. He was previously engaged at the institute in research on the gum fellowship.

Alexander C. Brown, M.S. (Mass. Inst. Tech., '26), has been added to the personnel of the multiple industrial fellowship on fatty acids. Before going to Pittsburgh, he had spent a year in Germany and two years in industrial work on petroleum.

Jasper S. Brown, B.S. (Maine, '26), has been appointed to the multiple fellowship on petroleum production. His previous experience was gained at the Pittsburgh Station of the U. S. Bureau of Mines.

Frank L. Jones, M.A. (Columbia University, '27), has been appointed to the enamels fellowship. Before accepting this position he was engaged in work toward the doctorate at Columbia, and he has also had teaching and industrial experience. He is succeeding B. A. Rice, who has joined the Pfaudler Company.

Ronald B. McKinnis, Ph.D. (Pittsburgh, '30), has been appointed to the can fellowship.

S. M. Martin, Jr., M.S. (North Carolina, '29), has joined the research staff of the multiple industrial fellowship on petroleum refining. Before going to the institute, he had had several years' experience in rubber technology.

Daniel C. L. Sherk, Ph.D. (Wisconsin, '20), has been appointed to the wood by-products fellowship. He has been engaged in industrial work since receiving his doctorate.

Thomas H. Swan, Ph.D. (Ohio State, '24), has been appointed to the garment fellowship. Since 1924 he has been the holder of the institute's bed fellowship.

A. J. Teplitz, B.S. (Kansas, '26), has been appointed an industrial fellow on the petroleum production fellowship.

Richard B. Unangst, B.S. (Lafayette, '16), has joined the personnel of the multiple utensil fellowship. Since 1916 he has been engaged in industrial work.

THE MICHIGAN ACADEMY OF SCIENCE, ARTS AND LETTERS

THE thirty-fifth annual meeting of the Michigan Academy of Science, Arts and Letters will be held in Ann Arbor on March 20, 21 and 22, 1930. The officers of the year are:

President—Oliver Kamm, Parke, Davis and Company, Detroit
Vice-president—Arthur E. R. Boak, University of Michigan
Secretary—Dow V. Baxter, University of Michigan
Treasurer—E. C. Prophet, University of Michigan
Editor—Peter Okkelberg, University of Michigan
Librarian—W. W. Bishop, University of Michigan
Section chairmen:
  Anthropology, Fred Dustin, Saginaw
  Botany, Frieda Cobb Blanchard, Ann Arbor

Economics and sociology, L. H. Seltzer, Detroit
Fine arts, Carleton Angell, Ann Arbor
Forestry, S. A. Graham, Ann Arbor
Geography, Wade DeVries, Lansing
Geology and mineralogy, Chester B. Slawson, Ann Arbor
History and political science, Howard B. Calderwood, Ann Arbor
Language and literature, F. W. Peterson, Ann Arbor
Mathematics, R. C. Shellenberger, Bay City
Sanitary and medical science, W. L. Mallmann, East Lansing
Psychology, W. C. Trow, Ann Arbor
Zoology, R. A. Muttkowski, Detroit

PRESENTATION OF THE JOHN FRITZ MEDAL

The John Fritz medal was presented to Dr. Ralph Modjeski, member of the American Society of Civil Engineers, of New York and Chicago, at the annual banquet and reception of the society in the Hotel Commodore, New York City, on the evening of January 15. Approximately six hundred members and guests of the society were present. Immediately following the dinner Mr. Harrison P. Eddy, member of the society, as master of ceremonies, presented the newly elected president of the society and three honorary members, and then resigned the chair to Bancroft Gherardi, past-president of the American Institute of Electrical Engineers, as chairman of the John Fritz Medal Board of Award.

Mr. Gherardi spoke briefly of the purposes and history of the medal and introduced Mr. J. V. W. Reynders, past-chairman of the board of award and past-president of the American Institute of Mining and Metallurgical Engineers. Mr. Reynders summarized the achievements of the twenty-five preceding medalists, in subject groups, and then outlined Dr. Modjeski's personal history and emphasized his contribution to the art of bridge building, especially during the period of construction of great bridges in the United States.

Chairman Gherardi then presented Past-President Dexter S. Kimball, of the American Society of Mechanical Engineers, as chairman of the board which made the award to Dr. Modjeski, who spoke of the great contributions to human life made by engineers and scientists in the fields of machine tools, application of power, transportation and communication. He also alluded briefly to great contributions of the sanitary engineer and of the medical research men for the benefit of public health and of the engineering educator to the general advancement of the practice of the profession.

Following his address and in accordance with established custom, Dr. Kimball, as chairman of the board, presented the medal and certificate to Dr. Modjeski for "notable achievement as an engineer of great bridges combining the principles of strength and beauty." Dr. Modjeski responded briefly, accepting the honor.

SCIENTIFIC NOTES AND NEWS

As was reported in a recent issue of Science, Professor Michelson, having recovered from a serious attack of pneumonia, expects to return soon to Pasadena in order to continue by new methods his measurements of the velocity of light. The following appears in the London *Times* for January 8: "The death of Professor A. A. Michelson at the age of seventy-seven, announced at a recent meeting of the Académie des Sciences of the Institut de France, of which he was a corresponding member, deprives the scientific world of a physicist of original genius and remarkable achievement." There follows an extended obituary notice. Reference is made here to the matter in order that in so far as possible the anxiety caused by these announcements may be relieved.

A less serious error has occurred through the circumstance that it was cabled by the Associated Press from Stockholm that the Nobel Prize in physics had been awarded to the Duc de Broglie for his work on "Wave Mechanics." Duc Maurice de Broglie has accomplished distinguished work on X-rays, including their diffraction by crystals and the proof of Einstein's photoelectric equation in the region of X-ray frequencies, which in the opinion of physicists would warrant the award of a Nobel Prize to him. The work on the relation between waves and particles has, however, been accomplished by the younger brother of the Duc, Louis de Broglie, and it is to him that the Nobel Prize has been awarded.

Dr. J. C. Arthur, professor emeritus of botany at Purdue University, celebrated his eightieth birthday on January 11. At a luncheon held in his honor by the staff of the department of botany of the Agricultural Experiment Station, Dr. Arthur gave an account of the earlier work and the development of the department of which he was head from its founding in 1888 to his retirement in 1915. Since retiring Dr. Arthur has been actively engaged in a continuation of his studies of rusts, having just published a book entitled "Plant Rusts."

Monday, January 13, marked the twenty-fifth anniversary of Dr. P. A. Levene's connection with the

Rockefeller Institute for Medical Research. The occasion was celebrated by a luncheon at the institute, attended by the entire staff and by many former coworkers of Dr. Levene, some of whom traveled great distances to be present. Brief addresses were made by Dr. Simon Flexner, director of the institute, and by Drs. W. A. Jacobs and Alexis Carrel, of the institute staff. A handsomely bound eight-volume set of his published articles was presented to Dr. Levene, who concluded the celebration with an address on "The Aims and Tools of Organic Chemistry and Biochemistry."

DR. FRIEDRICH KÜSTNER, director emeritus of the Bonn Observatory, has been made an honorary member of the American Astronomical Society, according to the provision that permits the election of one such member each year. Seven other living astronomers have been thus honored: Dyson, Charlier, Turner, Baillaud, Eddington, Wolf and Deslandres. A correspondent writes: "Küstner is best known for his detection, in 1888, of the variation of latitude, from observations made with a zenith telescope at Berlin. His two fundamental star catalogues, carried out with the meridian circle at Bonn, are unexcelled in accuracy and thoroughness, and are universally regarded as models for this class of work. With the comparatively modest equipment of the Bonn Observatory he has carried out a long series of determinations of radial velocities, and has shown that large telescopes are not necessary to secure results of a high order of accuracy. As a by-product of this work he was the first to determine the parallax of the sun by observing radial velocities of stars."

J. B. TYRRELL, consulting mining engineer and explorer, of Toronto, has been awarded the Daly medal of the American Geographical Society for his work in geography. The presentation was made by Dr. Isaiah Bowman, of New York, director and editor of the society, at a luncheon tendered Mr. Tyrrell by Sir Francis Younghusband, the British explorer. The David Livingstone Centenary medal was previously awarded to Commander Richard E. Byrd. This medal was not awarded by the National Geographic Society as previously stated.

THE Harrison Memorial lecture before the Pharmaceutical Society of Great Britain was delivered on January 14 by Mr. P. A. W. Self, who was presented by the president of the society with the Harrison medal. This lectureship and medal were established to perpetuate the memory of Colonel E. F. Harrison, director of chemical warfare during the war, and a distinguished member of the Pharmaceutical Society. The prize founded by the Chemical Society in 1922, in memory of Colonel Harrison, has been awarded to Dr. R. P. Linstead. This prize is awarded every three years to the chemist, under thirty years of age, who during the preceding five years has produced research work judged to be of the greatest merit and promise. The prize will be presented at the annual meeting of the Chemical Society in March.

AT the Des Moines meeting of the Mathematical Association of America, the Chauvenet prize of one hundred dollars was awarded to Professor T. H. Hildebrandt, of the University of Michigan, for his paper, "The Borel Theorem and its Generalizations" in the *Bulletin* of the American Mathematical Society for 1926. This prize is awarded every three or four years for the best expository paper published in English during the period of the preceding three or four years by a member of the association.

W. T. MACOUN, Dominion horticulturist, has been awarded the Wilder silver medal, given by the American Pomological Society annually, in recognition of his accomplishments in fruit breeding and horticulture generally.

R. HARCOURT, professor of chemistry at the Ontario Agricultural College, and A. T. Charron, assistant deputy minister of agriculture for Canada, have been honored by the French Government with the award of the Cross of Agricultural Merit. The award is the result of the visit to Canada in August, 1929, of a group of students and faculty from the National School of Agriculture at Grignon, France, and of the assistance given towards the success of that visit.

DR. A. S. EDDINGTON, Plumian professor of astronomy at the University of Cambridge, was elected president of the Mathematical Association, London, at the annual meeting on January 6.

MR. CARL E. GRUNSKY was elected president of the American Engineering Council at the meeting held in Washington on January 10.

DR. VERNON C. ROWLAND, associate professor of general and physical diagnosis, Western Reserve University Medical School, was recently elected president of the Academy of Medicine of Cleveland.

DR. ARTHUR H. LIBBY, Boston, was elected president of the Harvard Odontological Society for the coming year at the annual banquet of the association. Dr. Leroy M. S. Miner, of Boston, was chosen president-elect.

OFFICERS of the Philosophical Society of Washington have been elected as follows: *President*, W. D. Lambert, of the U. S. Coast and Geodetic Survey; *vice-presidents*, F. E. Wright and H. L. Curtis; *corresponding secretary*, L. V. Judson; *recording secretary*, O. S. Adams; *treasurer*, N. H. Heck.

In recognition of services rendered to the New York Academy of Medicine, Dr. Arnold C. Klebs, of Nyon, Switzerland, has been appointed consulting librarian of bibliography, and Professor B. W. Weinberger, of New York University, consulting librarian of dental literature.

Mr. Thomas A. Edison, Mr. Clarence Lewis, and Dr. E. D. Merrill, newly elected director, were elected members of the board at a recent meeting of the trustees of the New York Botanical Garden. The present officers, excepting the secretary, Dr. Nathaniel L. Britton, retiring director-in-chief, were reelected. Dr. Merrill was elected to succeed Dr. Britton as secretary and Dr. Marshall A. Howe was chosen assistant secretary.

Dr. Sidney W. Bliss has been appointed head of the department of biochemistry at Tulane University of Louisiana School of Medicine, New Orleans.

Fred C. Meier, extension pathologist, Office of Cooperative Extension Work, Extension Service, has been transferred to the position of principal pathologist in charge of barberry-eradication work of the Bureau of Plant Industry. This work has been separated from the Office of Cereal Crops and Diseases, Bureau of Plant Industry, and hereafter will be developed as a separate office of the bureau. Reorganization of the work will be undertaken immediately by Mr. Meier, with the idea of developing a more definite federal and regional basis of operation, although continuing close cooperation with the thirteen spring-wheat states and with the conference for the Prevention of Grain Rust. Dr. E. C. Stakman, of the department of plant pathology and botany of the University of Minnesota, who has long been identified with the black-stem-rust problem of wheat, especially with the epidemiological and related research, will act in an advisory capacity.

Dr. Harlan H. York, for seven years connected with the New York State Conservation Department, has resigned to accept the chair of forest pathology at the University of Pennsylvania. Dr. York was formerly a specialist in forestry at Brown University and the University of West Virginia and is chairman of the National Shade Tree Conference.

Oscar T. Quimby, chemist on the staff of the U. S. Forest Products Laboratory, assigned to experiments on the electro-endosmosis of wood, has resigned to take a position in the research division of the Procter and Gamble Company, Cincinnati.

Dr. Alexander Nelson, formerly superintendent of research in the Department of Agriculture in Tasmania, has been appointed lecturer in the department of botany of the University of Cambridge, and Dr. W. H. McCrea, formerly senior scholar of Trinity College and Isaac Newton fellow in the University of Cambridge, has been appointed lecturer in the department of mathematics.

W. H. Hoover, of the Smithsonian Institution, has returned from a three-year stay at Mount Brukkaros in South Africa, where he has been carrying on solar radiation investigations for the Smithsonian Institution and the National Geographic Society.

Dr. Rudolph Matas, emeritus professor of general and clinical surgery, Tulane University of Louisiana School of Medicine, has returned from a tour of Europe of several months' duration which was undertaken following his attendance at the International Congress of Surgery at Warsaw.

Dr. T. Shido, professor in the Kyushu Imperial University, and Dr. K. Iwakawa, professor in the Niigata Imperial Medical College, left in October to familiarize themselves with medical education in America and Europe.

Dr. Masayoshi Sato, professor of dairy chemistry, Hokkaido Imperial University, Japan, visited the United States in December on his return to Japan from a meeting of the executive committee of the International Dairy Federation held in Paris in October. The next World's Dairy Congress will be held in Copenhagen in June, 1931.

Dr. S. A. Waksman, soil microbiologist of the New Jersey Experiment Station, who has returned from Europe where for several months he has visited laboratories and experiment stations where microbiological work is being carried on, recently addressed the technical staff of the Bureau of Chemistry and Soils in Washington.

The council of the University of Melbourne has appointed Dr. R. Marshall Allan to the chair of obstetrics. Dr. Allan will devote the whole of his time to the organization of teaching and research.

Dr. M. Miura, a member of the Physical and Chemical Research Institute, Tokyo, died on November 20.

Dr. C.-E. A. Winslow, head of the department of public health at Yale Medical School and since 1927 assessor of the health committee of the League of Nations, delivered the second Aldred lecture at the Massachusetts Institute of Technology on January 17, when he discussed "Health Conservation—A Problem in Citizenship." Dr. Winslow also addressed the faculty club, speaking on "Ten Years' Work of the League of Nations."

Dr. Leon J. Cole, professor of genetics at the University of Wisconsin, will give a series of lectures open to graduate students in biology during the summer session of 1930 at Western Reserve University. These lectures will deal with two related subjects, namely, "Genetics of Populations" and "Genetics and Evolution."

J. L. ST. JOHN, state chemist and head of the division of chemistry, Agricultural Experiment Station, State College of Washington, Pullman, is arranging a trip to be undertaken by Dr. H. E. Howe, editor of *Industrial and Engineering Chemistry*, for the purpose of addressing various groups at certain educational institutions, local sections of the American Chemical Society and other audiences. It is anticipated that the tour will begin the first of February, extend through the northern tier of states to Seattle, thence south to Los Angeles, and eastward through the southwestern states, occupying in all about six weeks. Those who may be interested in this project are invited to correspond with Professor St. John.

DR. M. M. LEIGHTON, chief of the Illinois State Geological Survey, Urbana, began a series of lectures at the department of geology, Northwestern University, on December 4 and 5. Dr. Leighton had for his subject "The Weathering Characteristics of the Glacial Drift Sheets of the Mississippi Valley States." On December 5, under the auspices of the Dip and Strike Club of Northwestern University, he delivered a lecture of popular nature on "The Economic Importance of the Glacial Drift of Illinois." The series was continued on December 10 and 11, with lectures on "The Relations of the Loess Deposits to the Various Drift Sheets and Their Chronology," and on "The Drainage of Ice Sheets and Its Influence on Morainal Building."

PROFESSOR DOUGLAS JOHNSON, of Columbia University, has recently delivered addresses in South Africa, Australia and New Zealand as follows: "The Face of the Waters," British Association, Cape Town; "Methods of Physiographic Research," geological department, University of Perth; "Studies in Shoreline Physiography," geological section of the Royal Society of New South Wales, Sydney; "Shore Problems," Royal Society of Queensland, Brisbane; "Physiography of the Atlantic Shoreline," geological section of the Philosophical Society, Wellington.

PROFESSOR P. EHRENFEST, of the University of Leiden, has accepted an invitation to participate in the Symposium on Theoretical Physics at the University of Michigan during the coming summer. In addition to giving a series of lectures, he will direct the informal conferences which accompany the lectures. Subsequently Professor Ehrenfest will visit several other universities throughout the country.

THE General Education Board, New York, has authorized grants to Duke University School of Medicine, amounting to $300,000 over a period of five years. It is also announced by the dean that the new medical school will open on October 1, and will admit first and third year students. The school will follow the four-quarter plan.

DISCUSSION

OVERHEAD SOUNDS OF THE YELLOWSTONE LAKE REGION

IN *Nature Notes from Yellowstone Park*,[1] Mr. L. S. Morris, ranger naturalist, describes aerial sounds which were heard by himself and companions over Grebe Lake, near the canyon of the Yellowstone in the park.

After reading Mr. Morris's narrative, I looked over a communication of my own to SCIENCE.[2] I also reread the notes upon which that communication was based.

Since there are some items in these notes which were not included in the published account it seems to me, especially in view of recently awakened interest in these phenomena, to be worth while to make a record of them.

Following are all the references to overhead sounds which I find in the diary which I kept during the six weeks of our stay in the park. I copy from the diary without making any changes in the text, such comments as seem to be called for being enclosed in parentheses.

(1) July 23 (1890). Yesterday, when (Elwood) Hofer and I were on our way to the upper (western) end of the lake (Shoshone), I heard a strange noise, which I supposed was off to the southward and echoing among the mountains. (At the time, about 8 A. M., I was seated in our Osgood canvas boat, with the oars in my hands, but not rowing. I was probably ten or twelve feet from the shore, where Hofer was seated measuring off our dredge rope, which we were going to use for a sounding line. As I remember the situation we were from twenty to thirty feet apart.) Hofer asked me what I thought it was, and where it seemed to be. I told him the apparent direction and asked him what it was. He replied that it was the most mysterious sound that was heard in the mountains. Since then we have talked about the sound a good deal in camp, and this morning heard it again very plainly. (My recollection of this event is that it occurred just after we had had breakfast, and

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[1] 6: 2–4.

[2] First series 22: 244–6, November 3, 1893.

before we had separated for the day's work.) This time it appeared to be directly overhead, and to pass off across the sky, growing fainter and fainter toward the southwest. Hofer and Dave Rhodes, both of whom have had wide experience in the mountains, agree in their testimony in regard to it. They say they have never heard it anywhere out of the park, except to the south, about the forty-fourth parallel, some thirty miles south of here. He (Hofer) does not remember to have heard it farther west than Shoshone Lake, or east than Yellowstone Lake—not to the north of these points. It is heard mostly in the morning, shortly after sunrise, and up to, perhaps, half past eight, or nine o'clock. Hofer says he has heard it in the middle of the day, but usually not later than 10 o'clock A. M., doesn't remember to have heard it before sunrise. The description given of the sound before I heard it and since agree with my observations with regard to it. (The meaning of this somewhat obscure sentence is that the descriptions which Hofer and Rhodes give of the sound as they have heard it on previous occasions and their description of the sound as they have heard it here on Shoshone Lake agree with my own observations.) When heard best it appears to be a rather indefinite, reverberating sound in the sky, with a slight metallic resonance, which begins, or at least is at first perceived, overhead; at least, nearly every one in attempting to locate it turns his head to one side and glances upward. (I remember that while I was having my first experience with this sound in the sky I noticed that Hofer was watching me very closely. Later I found that he had been observing my reactions. He told me that people invariably behaved that way when they were trying to locate the source of the sound. I had at first looked up, and then had tried to follow the diminishing sound toward the southwest.) The sound is as difficult to describe as an echo, which has been repeated several times in quick succession. Each time I have heard (it) here on Lake Shoshone it appeared to begin to the southward, or, when first noticed, beginning overhead, or, as some one (Dave Rhodes) expressed it, "all over," and moving off toward the south.

(2) Camp on the "Thumb," Yellowstone Lake. August 4. While out on the lake this morning Professor Forbes and I heard again the strange noise which we heard several times on Shoshone Lake. It was about 8 A. M., morning still and clear, lake quiet, sun beginning to shine with considerable power (this mention of overhead sounds was preceded by an entry, which may, of course, have nothing to do with this phenomenon: "minimum temperature last night 33.5° F."); sound loudest almost overhead—seemed to pass to the southeast (so it stands in my diary. Since my other entries, where the apparent direction of these elusive sounds is recorded, indicate a direction west of south, which is in accord with my recollection of these events, I am inclined to think that this may be an example of those slips which Oliver Wendell Holmes cites in "Over the Teacups," where one writes north when he means south, and the like); sound of same nature as that heard on Shoshone (Lake)—very hard to describe—a certain metallic resonance—Professor Forbes calls it a kind of twisting, yow-yow vibration, resemblance to sound made by telegraph wires, but not a steady, uniform volume. The sound lasted probably half a minute, time not noted. As I have heard the sound here it seemed to begin at a distance, something like a mixture of wind in pine tops, in telegraph wires, the echo of bells, after being repeated several times, the humming of a swarm of bees and two or three other sources of sound, all making a not loud, but easily recognized sound, not at all likely to be mistaken for any other sound, but easily overlooked if one is surrounded by noises. The party on shore heard the same sound at the same time that we heard it on the lake. (On this occasion Professor Forbes and I were in our canvas boat, one hundred yards, more or less, from shore. Hofer was on the beach at the water's edge. The others were at the camp, which was some fifty feet or more back from the edge of the lake terrace, in a grove of pine-trees. I have a kodak picture of the scene which was taken from our boat as we were nearing shore on our return from this trip.) Hofer says he doesn't remember to have heard it when the sky was cloudy, has heard it when "quite considerable breeze" was blowing. Remembers that he has usually heard it when the sky is clear, or with few clouds, and the morning calm; as a rule in the morning, but has heard it as late as noon. Dave Rhodes thinks he has heard it only in the mornings, and when the sky is clear, or with light, fleecy clouds.

(3) August 8. Professor Forbes and I rowed up to Bridge Bay (northwest end of Yellowstone Lake), where we collected—back (to hotel) about 12: 30 (P. M.). . . . We heard our mysterious sound again this morning, at 10 and 10: 15, while out (on the lake) collecting. There is reason to believe that it is caused by the steamboat *Geyser* (on east shore of the lake), and heard through some peculiar condition of the atmosphere at distances of several, perhaps thirty to fifty miles away. (Here I seem to have arrived at that state of mind where consolation is derived from belief in a theory.)

(4) August 9. 2: 20 P. M., at head of southeast arm of (Yellowstone) lake. While in boat heard sound overhead, like rushing wind traveling very rapidly or like something rushing through the air, did not have the semimetallic sound, or like echo; seemed to travel from east to west; clear, except light, fleecy and feathery clouds, enough wind to ruffle the surface of the water. (On this occasion I was one of a party of five which had left the Lake Hotel on the afternoon of the eighth in two rowboats, with tent and camp outfit. My companions, who were engaged on the construction of a new building, were Mr. L. D. Boothe and Messrs. Couglin, Curl and Thomson. Mr. Curl and I were in one boat, the three others in the other. We were making our way from the east to the west side of the east arm of the lake, and were rowing slowly in the very shallow water of this part of the lake when the sound attracted our attention.)

The following note is included in Mr. Morris's article: "In the *Ranger Naturalists' Manual* for 1928 there appears a rather complete summary of the recorded observations of this weird phenomenon by Ranger Marguerite Arnold."

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THE NORMALITY OF THE MATURATION DIVISIONS IN THE MALE OF DROSOPHILA MELANOGASTER

In a recent article in Science, "Recent Discussions of the Reduction Division in *Drosophila melanogaster*," Jeffrey[1] has assailed Belar's[2] conclusion that the maturation phenomena in this form are normal. For the past six months the writer has been studying maturation and allied phenomena in the male gonads of *D. melanogaster* and, since my observations seem to explain quite simply the anomalies reported by Jeffrey in his preparations, a brief description of my results is given below.

The gonads of larvae of varying ages were quickly dissected in a 2 per cent. urea solution and transferred immediately to strong Fleming's fluid containing 1 per cent. of urea by volume. After fifteen to thirty minutes the tissue was placed in Herman's fluid containing 1 per cent. urea and fixed for three hours. This is the technique used by Painter in his translocation studies.

When primary spermatocytes stained with iron hematoxylin were first studied, the number of darkly staining elements observed was larger than was expected from the diploid chromosome number in the male, but further examination revealed a great variation in the number and size of these stained bodies. On close study, these structures could be separated into two groups, the first made up of the four tetrads, identified by their shape, and the second containing the other bodies which did not stain so intensely as the tetrads and whose shape was usually spherical. Often these spherical globules appeared quite hollow, and they exhibited no definite relation to the equatorial plane. It was variation in the amount of this second type of material which gave the impression of variable chromosome number. As these observations suggested that the material included in the second group was not chromatin, differential strains were used. After being stained with Auerbach's acid fuchsin-methyl green, the tetrads were green, while the other elements were bright red. More extensive study of numerous preparations gave the following facts: (*a*) a very large acidophilic nucleolus is present in the growth period of the first spermatocyte. It is usually spherical but it may appear as a mass of globules. (*b*) There is no regularity in the time at which the nucleolus breaks up and loses its capacity to retain the stain. In some instances it ceases to stain before the first maturation spindle is formed, while in other cells it breaks up into a number of globules which take the stain well, even as late as the telophase of this division. This behavior of the plasmosome explains the variation in the amount of the apparent chromatin in the first maturation spindle. If it disintegrates before the spindle is formed, only the tetrads are present at the time of division, while if it has fragmented but has not lost its capacity for staining, the products lie in the region of the spindle and stain with iron hematoxylin, giving the appearance of true chromatin.

There are four tetrads in the first maturation spindle, conforming in size to what might be expected from the diploid chromosomes. They divide normally with the X and Y elements segregating to the opposite poles. If plasmosomes are present in the cell, they tend to be roughly distributed to the two poles, but they are never included in the new nucleus. By the second maturation division the plasmosomes have usually disappeared and the chromosomes are easily studied. Their division at this time is normal.

These facts seem to give a simple explanation of the figures published (and demonstrated) by Jeffrey. In his cells there were two types of material, chromosomes and plasmosomes; but, due perhaps to the preservative used, the true tetrads could not be identified by their shape, as in my material. The structures described by him as "chromosomes . . . far removed from the equatorial line" are obviously the same as the deep-staining bodies which I have found in similar cells and which give an acidophilic reaction with differential stains. The irregular distribution of the plasmosome material to the cytoplasm of the two daughter spermatocytes, in my opinion, has been misinterpreted by Jeffrey as the elimination of true chromatin.

From my observations I am forced to conclude that the maturation process in *Drosophila melanogaster* is normal as far as chromosomes are concerned. Why the plasmosomic material should show such variation in the time it loses its staining capacity is not clear, unless it be due to the great rapidity with which maturation is carried on in this form.

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SAND-STORM ELECTRICITY

I have read with much interest the discussions on atmospheric electricity in Science for March 30, 1928; May 3, 1929, and October 18, 1929. On June 23, 1927, I read a paper on "Some Remarkable Electrical Conditions Accompanying West Texas Sandstorms" before the American Physical Society at Reno, Nevada, which paper was abstracted in the *Physical Review*, 30: 362, September, 1927.

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[1] Science, 70: 579–580, December 13, 1929.

[2] "Die cytologischen Grundlagen der Vererbung," Berlin, Gebrüder Borntraeger, 1928.

Of the four papers mentioned above, it seems to me that only two refer to anything like similar conditions. The experiments of Brasch, Lange and Urban, in Switzerland, were made during thunderstorms. The air was probably quite free from dust. Nothing is said on that particular point, but one would expect the air to be quite pure in the mountains of Switzerland. The observations of Benade, in India, seem to have been made when a variety of atmospheric conditions were present such as sand, dust, rain and lightning. I take it for granted that the climate in that part of India is quite moist, although the author says nothing on that subject. The observations of Canfield in New Mexico and of George, Young and Hill at this school were made under cloudless skies when rain, thunder and lightning were conspicuous by their absence. As a matter of fact, west Texas sand-storms are generally accompanied by a humidity so low as to be almost unmeasurable. I believe it is generally understood that whatever the cause of sand-storm electricity may be, it is altogether different from that which is responsible for the electrical display during thunder-storms.

By reference to the above-mentioned abstract it will be observed that we obtained voltages about twice as high and currents about six times as great as those observed by Benade. As to the magnitude of the current, however, I think it probable that, under given conditions, it varies directly with the total area of the collector. That, however, remains to be verified. Our collector was a radio aerial consisting of a single *stranded* wire 33.75 meters long arranged east and west in a nearly horizontal position, with a lead-in wire about one third as long.

I think Benade is quite right in intimating that the *effect is not due entirely* to friction. Recently Dr. W. H. Abbitt, of this laboratory, has made observations which seem to indicate that an effect may be obtained during a sand-storm from a loop aerial located in a practically dust-proof laboratory. These observations, however, need confirmation.

The climatic conditions at Jornado Range are probably quite similar to those in west Texas, and Canfield's observations are very interesting to us here. I am inclined to think, however, that he is mistaken on one point, and that is with respect to the arc which he says he obtained. To maintain an arc three and one half centimeters long in the open air would require a current of quite a different order of magnitude from what I believe to be possible under the conditions of his experiment. Besides, the ends of the wire, under the intense heat of the arc, would have rapidly melted away. The melting-point of copper is not over 1080° Centigrade, while the temperature of the arc may run up to about 4000° Centigrade. I am of the opinion that what he observed was a succession of spark discharges which followed each other so rapidly that, due to persistence of vision, it seemed to be continuous. The noise, however, would probably be quite different from that of the arc. The glow which he obtained at night seems to have been a corona discharge.

There is a world of literature on the subject of atmospheric electricity dating back to and beyond the experiments of Lord Kelvin. An excellent résumé of the literature on the electrification of various kinds of dust and smoke is given in "Clouds and Smokes" by W. E. Gibbs published by J. and A. Churchill, London. But in spite of all that has been done in this field, a field pregnant with great potentialities, we have scarcely made a beginning. Dr. Abbitt has taken over the work on stand-storm electricity at this school. He is now working on a new type of apparatus for measuring the electrical potential of the atmosphere.

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ABSENT-MINDEDNESS AS A FACTOR IN PROFESSIONAL ETHICS

Several exceedingly interesting instances of professional ethics which have more or less recently come to my attention furnish food for thought. They are related here with essentially correct details but purposely disguised so that the authors, specialities and countries can not be identified; the purpose of this disguise (involving "not less than" in connection with the number of pages and number of illustrations) is to bring out underlying principles without embarrassing the authors. Upon relating these cases to some colleagues "in the club," a responsive chord was struck and I was urged to publish the instances.

The citations themselves can well be prefaced by the premise that practically all authors occasionally, however absent-mindedly and inadvertently, commit sins of omission or of commission. The instances here related represent somewhat extreme examples of absent-mindedness (if that be the correct technical term).

Case 1. An article of not less than forty pages, with not less than fifteen illustrations; ten of these are immediately recognizable to the initiated as copied from other authors, but no acknowledgment is given.

Case 2. An article of not less than six pages, with not less than eight illustrations; four of these are copied from other authors; acknowledgment is made for two of them.

Case 3. An article of not less than thirty pages, with not less than ten illustrations; four of these are copied from other authors; acknowledgment of source is given for one illustration.

Case 4. An article of not less than twenty pages, with not less than ten figures; at least five of these are copied (one from a deceased author); source is stated for one, not stated for three; one of these figures is copyrighted by another publisher.

Case 5. A specimen was sent by a collector to a certain specialist for determination. The determination was made and a detailed drawing of it was prepared, involving certainly many hours of intensive work. The collector asked to borrow the drawing and the specialist was delighted to lend it to him. In a few weeks this drawing was published by the collector in a copyrighted journal with no reference as to its source.

Case 6. The prize case for "absent-mindedness" is an article of not less than fifty pages, with not less than twenty-five illustrations, all given as "original." Some of these figures bear a remarkable resemblance to old friends, but there is something unnatural about them. The artist explained this interesting puzzle. He said (in effect): When Dr. X— wants an illustration, and finds one to suit him, I photograph it, then draw the negative [reversed] view; for instance, a left view now shows as a right view, and *vice versa;* of course the illustrations thus become original drawings.

Many other cases might be cited, but the foregoing are sufficient to remind us all that possibly none of us is entirely free from absent-mindedness. A story is making the rounds of Washington that a man of non-scientific training heard of "professional ethics" and expressed surprise when he learned that this was not some sort of a skin disease. Is it possible he had in mind the condition known as pachydermia?

C. W. STILES

U. S. PUBLIC HEALTH SERVICE

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A MODIFIED FORM OF NON-ABSORBING VALVE FOR POROUS-CUP ATMOMETERS

As was first pointed out by Livingston,[1] the porous-porcelain atmometer must be provided with an arrangement to prevent water absorption through the porous evaporating surface in periods of rain, fog or dew formation. This necessitates the presence of a valve in the tube that connects the porous cup with the water reservoir below, the valve being so constructed as to allow movement of water upward while it practically prevents downward flow. Livingston's original mercury valve[1, 2] has been modified in various ways, and several forms of it are now in use.[3] Another form of valve is that of Livingston and Thone,[4] which is now generally used.

In all these valves excepting the one last mentioned, the downward hydrostatic pressure of the water column in the supply tube is balanced by a mercury column of equivalent hydrostatic pressure acting in the opposite direction when free water is in contact with the outside of the porous cup above, as in times of rain. Although differing in detail these all consist essentially of a U-tube containing mercury inserted in the water-supply line from reservoir to cup. When water is moving upward it forces the mercury into one arm of the U-tube and then passes around it. When absorption through the atmometer wall begins mercury rises in the other arm until the mercury column in that arm balances the downward pressure of the water, when absorption and backward flow are halted. With each closure of this type of valve a small amount of water enters the reservoir. If a number of valve reversals occur in a period of operation (as when periods of absorption and evaporation follow each other on a day of frequent showers) the error thus introduced may be considerable,[5] but its magnitude is so small as to be practically negligible in most instances. The absorption error for each reversal of a value of this type is, of course, a volume of water equal to the volume of mercury held in the second arm of the tube when the valve is closed, and the bore of the tube used for this arm should therefore be as small as is practicable.

The Livingston-Thone valve consists of two porous plugs a centimeter or two apart in the vertical supply tube, with a small mass of mercury enclosed between them and resting on the lower plug. As water moves upward it passes around the mercury, the column of which is only a few millimeters high, but downward flow is prevented because the mercury mass acts like an ordinary poppet valve, seating itself on the lower plug, into the pores of which mercury does not enter to any considerable extent with the low hydrostatic pressure involved. The plugs are now commonly made of sheep's-wool yarn, and the absorption error of a valve of this type, when well made, is much smaller than the corresponding error in a valve of the U-tube type. However, this type of valve requires some attention from time to time, especially because the pores in the plugs are likely to become closed by algal growth or bacterial slime, which may accumulate rapidly at summer temperatures. When the upper plug becomes partially sealed the operation of the instrument may be prevented by the accumulation of gas between the two plugs. When the lower plug is too loose mercury may escape downward.

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[1] B. E. Livingston, "A Rain-correcting Atmometer for Ecological Instrumentation," *Plant World*, 13: 79–82, 1910.

[2] B. E. Livingston, "Atmometry and the Porous Cup Atmometer," *Plant World*, 18: 21–30, 51–74, 95–111, 143–149, 1915.

[3] Frank Thone, "Rainproofing Valves for Atmometers: A Résumé," *Ecology*, 5: 408–414, 1924.

[4] B. E. Livingston and Frank Thone, "A Simplified Non-absorbing Mounting for Porous Porcelain Atmometers," SCIENCE, 52: 86–87, 1920.

[5] E. M. Harvey, "The Action of the Rain-correcting Atmometer," *Plant World*, 16: 89–93, 1913.

In the extensive evaporation survey now being carried on in Ohio, atmometers equipped with valves of the plug type required frequent inspection by an expert, and the valve described below has been used throughout the past season. It is of the U-tube type and is much like the valve used in the Shive mounting,[6] but is constructed to pass through the opening of an ordinary thirty-two-ounce bottle with small mouth.

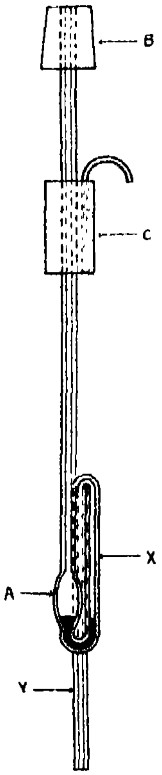

Fig. 1. Non-absorbing atmometer valve.

The accompanying diagram shows an atmometer mounting equipped with the new device. The rubber stopper *B* carries the atmometer sphere, and the cylindrical cork stopper *C* fits tightly in the bottle mouth. The cork carries a bent copper tube by which air is allowed to enter the bottle without danger of water entrance in rainy periods. The valve itself is continuous with the supply tube, the whole being made of glass barometer tubing having an outside diameter of 6 mm and a bore of about 1.5 mm. A piece of tubing about 41 cm long is used for each mounting. The valve consists essentially of a narrow loop made by two sharp bends, each of 180°, with a bulb *A* at the lower end of the long portion that leads directly to the atmometer sphere above. The first ascending part *X* is about 7 cm long, and the descending part *Y* is long enough so that the whole mounting is about 30 or 31 cm long. The bulb *A* has an internal diameter of at least 5 mm and a total length of about 2 or 2.5 cm. The capacity of the bulb is about 1 cc. The *X* and *Y* portions must be very close to the bulb, in order that the valve may pass through the 18-mm mouth of the bottle reservoir. The bend below the bulb should also be as close to the latter as possible so that the absorption error inherent in valves of this type may be small. The error in this valve is about 0.1 cc.

When evaporation is going on and water is ascending through the valve, the mercury (indicated as black in the diagram) all lies in the bulb *A* but does not fill it, and water flows upward around the mercury. As soon as absorption exceeds evaporation some of the mercury in the bulb passes around into the portion *X*, which has a small bore, until the hydrostatic pressure that produces absorption is balanced by the narrow mercury column extending above the level of the mercury meniscus in the bulb. It is seen that the parts *A* and *X* constitute the essential U-tube mentioned above.

To install this mounting the bulb is first filled about one third full of mercury. Then a piece of flexible rubber tubing, about 10 cm long and supplied with an open pinch cock, is attached to the lower end of the *Y* portion. The free end of this piece of tubing is then placed in water and gentle suction is applied at the upper end of the mounting until all gas in the system has been displaced by water. The pinch cock is then closed, the mounting inverted and the rubber stopper *B* tightly seated in the neck of the atmometer sphere, the latter being completely full of water. Finally, the mounting is returned to the upright position (with the sphere above), the rubber tube is removed and the mounting is quickly set into the reservoir bottle, which has been previously filled or nearly filled with water. After a few hours the reservoir may be filled to the mark on its neck for the beginning of a period of observation.

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[6] J. W. Shive, "An Improved Non-absorbing Porous Cup Atmometer," *Plant World*, 18: 7–10, 1915.

About a hundred spherical atmometers with mountings like the one here described were in operation, in the Ohio survey mentioned above, during a nineteen-week period in 1929. With the exception of two, the valves of which were accidentally broken, all the instruments operated perfectly throughout the period without the attention of persons specially trained in caring for them.

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THE USE OF N-BUTYL ALCOHOL IN DEHYDRATING WOODY TISSUE FOR PARAFFIN EMBEDDING

THE common procedure in dehydrating, clearing and embedding tissue for cytological examination is, first, to replace the water normally present in the specimen with ethyl alcohol. The alcohol is then replaced by some volatile fluid soluble both in it and in paraffin. In the preparation of plant material for sectioning this fluid is nearly always xylene, which is in turn replaced by melted paraffin. On solidification the paraffin holds and supports the tissue so that it can be sectioned properly.

There are certain limitations to the above technique which make it unsuited for animal cells and for any plant material which contains lignified elements. The higher concentrations of alcohol harden any specimen left in them too long, often before it is completely dehydrated. All the water must be extracted from the specimen before the xylene will penetrate, and this involves the use of absolute alcohol. The xylene itself causes animal cells to shrink and become brittle and so hardens the wood elements that they can not be cut but break and chip the edge of the microtome knife. These disadvantages have been overcome in the preparation of small zoological specimens by using clove oil, cedar oil, chloroform, etc., in place of xylene. Painter[1] has developed a method of substituting aniline oil for the higher concentrations of alcohol, replacing the aniline oil with methyl salicylate (oil of wintergreen) and passing from the latter into paraffin. This method does not harden wood provided the specimen is carried through very gradual changes. The several liquids diffuse so slowly, however, into half-inch cubes composed of xylem, cambium and phloem that the method is impractical for this material.

Mlle. Larbaud[2] has dehydrated and cleared with a mixture of ethyl and n-butyl alcohols. Butyl alcohol is soluble in paraffin in all proportions, but only 8.3 grams are soluble in 100 cc of water. A mixture of equal parts of ethyl and butyl alcohol, however, is completely miscible with water. Larbaud based her technique upon the ethyl alcohol-xylene series: 30 per cent., 60 per cent., 80 per cent., 95 per cent., absolute alcohol, 2 pts. absolute alcohol-1 pt. xylene, 1 pt. absolute alcohol-2 pts. xylene, xylene. She shortened the above eight stages to six by using equal parts of ethyl and butyl for the alcohol of the first four stages followed by two changes of pure butyl alcohol.

Small cubes of wood with cambium and phloem attached require more gradual dehydration. The following series of mixtures of water, ethyl and butyl alcohol has been satisfactory:

Water	95–89–82–70–50–30
Ethyl alcohol	5–11–18–30–40–50
Butyl alcohol	0– 0– 0– 0–10–20

One hour is generally enough for each step except the last. The material should remain over night in this solution which contains a total of 70 per cent. alcohol. It should be emphasized here that alcohol not only dehydrates the tissue but also, as a powerful reducing agent, completes chrome fixation by reducing the chromate ion ($^{--}CrO_4$) to the chromic (Cr^{+++}). Keeping the specimen in alcohol over night eliminates certain irregularities in the fixation images of various chromic compounds (Zirkle[3]).

The dehydration is completed by the stages:

Water	15– 5– 0– 0– 0
Ethyl alcohol	50–40–25– 0– 0
Butyl alcohol	35–55–75–100–100

An hour in each stage is generally sufficient except that the tissue should remain in the pure butyl alcohol until *all* the water is extracted.

As butyl alcohol dissolves solid paraffin extremely slowly, nothing is gained by placing chips of paraffin in the vial of alcohol that contains the specimen and by waiting for them to dissolve in the cold. A simple method is to fill a vial two thirds full of paraffin, let the paraffin harden and place the material to be embedded upon it. Cover the specimen with butyl alcohol and place the vial in the oven. As the paraffin melts, the tissue sinks. Butyl alcohol, being lighter than melted paraffin, does not sink with the specimen which consequently comes into intimate contact with almost pure paraffin. Two changes of paraffin are generally sufficient, the length of each change depending upon the size of the specimen.

In spite of the fact that butyl alcohol diffuses into paraffin more slowly than does xylene, it has several advantages over the latter as a clearing agent. Its specific gravity is less, being .810 at 20° C. compared with .881 for orthoxylene and .866 for metaxylene.

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[1] *Anat. Record*, 27: 77–86, 1924.

[2] *Compt. Rend. Acad. Sci. Paris*, 172: 1317–1319, 1921.

[3] *Protoplasma*, 4: 201–227, 1928; 5: 511–534, 1929.

It is slightly lighter than paraffin at the latter's melting-point and when the specimen sinks, as described earlier, it remains floating on the paraffin. Xylene, on the other hand, is heavier than melted paraffin and sinks with and surrounds the specimen. There is an additional advantage in the use of butyl alcohol as slight traces of it in the paraffin blocks do not render them crumbly as does a like amount of xylene.

Butyl alcohol does not harden wood, and its use makes the higher concentrations of ethyl alcohol unnecessary. Any wood that can be sectioned green may be sectioned in paraffin if dehydrated, cleared and embedded as described above. Thus it is possible to get thin, smooth sections of the soft cambium and phloem even if hard xylem elements occur in the slices. Woods as hard as hickory (*Carya ovata*) and locust (*Robinia Pseudo-Acacia*) have been sectioned satisfactorily. The fine cytological details which can be investigated by this technique are destroyed by the prolonged hydrofluoric acid treatment, a necessary concomitant of the colloidin technique. However, butyl alcohol does not soften wood which has once been hardened by fixation, by drying, or by a too rapid dehydration, and all such material should be prepared for sectioning in other ways.

The simplicity of the butyl alcohol method, as pointed out by Larbaud, makes it preferable for other plant organs: buds, leaves, root-tips, etc. It is much quicker than the ethyl alcohol-xylene technique.

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SPECIAL ARTICLES

GEOLOGICAL EVENTS IN THE HISTORY OF THE INDIO HILLS AND THE SALTON BASIN, SOUTHERN CALIFORNIA

The landward extension of the long depression occupied by the Gulf of California has experienced a very eventful history during Tertiary time. In the course of an investigation of the Indio Hills, now in progress, several facts of geologic significance have been discovered.

The trough, extending northwestward for nearly three hundred miles from the head of the gulf, was formerly known as the Colorado Desert. Its topographic subdivisions, in order from the gulf northwestward to its head at San Gorgonio Pass which leads into the coastal portion of Southern California, are the Colorado River delta or alluvial cone, Imperial Valley, Salton Sink or Salton Sea, and Coachella Valley. It is flanked on the west throughout much of its length by high mountains, rising to a maximum height of about 10,000 feet; it sinks to about 275 feet below sea-level beneath the recently formed freshwater Salton Sea. Tertiary marine and continental sedimentary formations outcrop at various places along the margins and bottom of the trough and yield clues to its origin and geological history.

The area of these deposits which we are studying, known as the Indio Hills, lies north of Indio, in central Riverside County. A similar neighboring area to the southeast, known as the Mecca Hills, is being investigated by Mr. Hampton Smith.

The Indio and Mecca Hills trend northwest-southeast, and lie end to end. Each of the two areas measures about twenty miles long by two to six miles wide, and together they extend most of the distance from the Salton Sea to the northwest end of the Coachella Valley. They occupy a position parallel to and only slightly northeast of the median line of the broad depression. The hills rise about 1,000 feet above the plain and in the very arid climate exhibit a magnificent badland topography.

Our investigation is part of a broad program of Tertiary history studies initiated by Dr. John C. Merriam and sponsored by the Carnegie Institution of Washington.

1. We find that the upper part of the Indio Hills block is constituted of two formations. One of these is marine and is doubtless the correlative of the Carrizo formation, named by W. S. W. Kew[1] with type locality on Carrizo Creek, southwest of Salton Sea. It outcrops in the Indio Hills as small areas at several localities both east and west of the mouth of Thousand Palms Canyon and in the northern part of the hills. It consists of yellow clays with some sandstone and conglomerate. Its age was determined as upper Miocene by Ralph Arnold[2] and as lower Pliocene or younger by T. Wayland Vaughan.[3] The formation, containing a fauna related to that living in the Gulf of California and very distinct from the west coast invertebrate assemblages of California, records an invasion of the Gulf of California over the Indio Hills block. This incursion has been determined by other workers to have extended almost to San Gorgonio Pass.

The second formation is several thousand feet thick and consists entirely of arid-climate, terrestrial deposits. Clays, probably playa deposits, arkosic sandstones and fanglomerates with considerably worn fragments form in sub-equal thicknesses nearly the entire exposed section in the hills. For this areally and stratigraphically important set of rocks the name Indio formation is proposed, its type section being taken along a northeast-southwest line through the Indio Hills about two miles northwest of Thousand Palm Canyon.

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[1] "Tertiary Echinoids of the Carrizo Creek Region in the Colorado Desert," Univ. Calif. Publs., *Bull. Dept. Geol.*, 8: 2, 1914.

[2] U. S. Geol. Surv. Bull. 396, p. 44, 1909.

[3] U. S. Geol. Surv. Prof. Pap. 98, p. 369, 1917.

The Indio formation is part of the comprehensive Mud Hill Series of Free,[4] which includes all the Cenozoic strata of the region, both marine and continental. The marine portion was, as indicated, separated in 1914 as the Carrizo formation by Kew.

2. At all localities the Indio formation overlies the Carrizo formation. Considering both the striking difference in the nature of the sediments and in their mode of deposition the Indio is probably unconformable on the Carrizo.

3. We have secured no fossil material in the Indio formation, but its stratigraphic relations to the Carrizo formation on the one hand and the well-indurated character of the Indio formation on the other indicate a probable age not greater than middle Miocene and not less than lower Pliocene; in short, approximately middle Neocene.

4. The San Andreas fault, heretofore thought to skirt the northeast margin of the hills, has recently been located quite independently by Dr. Levi F. Noble in the course of his elaborate study of that important structural feature, and by us. It crosses the northwest end of the hills obliquely and then follows the southwest base.

5. Structurally the hills are strongly folded, and our mapping of axes indicates that the folds are not parallel to the margins or trend of the hills but strike somewhat more westerly so that they are cut off obliquely on the west by the bordering San Andreas fault. An interesting but as yet somewhat speculative inference from the trend of the folds is that while the initial and earlier movements on the San Andreas fault in this region may have been due to forces acting roughly parallel to it, the folding and more recent movement on the fault—northwestward shifting of the southwestern block relative to the northeastern—have probably been caused by forces acting from the south and at a considerable angle to the fault. It is quite possible that the eastward swing of the San Andreas fault in the Indio Hills region is related to the shortening across the Indio Hills block indicated by the folding. The above explanation for the folding of course relates the folding and the San Andreas faulting as to date; this is plausible, for while the folding occurred some considerable time ago, as indicated by the deep erosion of the hills, the San Andreas fault, though now active, is also known to have suffered movement intermittently far back in Tertiary time.

6. In a number of references, including a recent text-book, the Salton Basin is asserted to have been occupied so recently by the Gulf of California that it was separated from it by the building of the Colorado delta or alluvial cone. It appears to us much more probable, however, that the depression below sea-level of the present Salton Basin has occurred during or since the building of the delta or cone, not before, and long after the last invasion by the sea.

The possibility of concurrent depression and delta building, as contrasted with pre-delta depression, was first pointed out and discussed by Free[5] but not urged, probably because at that time less information was available regarding the age and structural relations of the formations.

The belief that the depression of the basin and the delta or cone building were contemporaneous and that the delta did not cut off an arm of the sea is based upon the following considerations.

(*a*) The delta or cone of the Colorado River is relatively young geologically, probably Quaternary in age, since it was superposed as a feature upon a landscape which already resembled the existing one, although not identical with it. The lowest line across the cone along which the sea might enter the Salton Basin, along the intersection of the west slope of the cone and the west wall of the basin, rises to only about thirty feet above sea-level. Hence, under the old view, the basin would have been connected with the gulf until the last or upper thirty feet of the cone was added. This fact coupled with the youthfulness of the cone would make the latest presence of marine or brackish waters an event of Recent or Quaternary time. But while deposits of a relatively recent fresh-water lake fed by the Colorado are excellently exposed in the basin, no marine beds of sufficiently late age or bearing expectable relations to the topography and to the sea-level contour have been anywhere encountered by the writers in journeys about the basin nor are such reported in the literature.

(*b*) While terraces referable to the recent fresh-water lake are conspicuous, no marine terrace or strand has anywhere been noted by the writers nor have such features been recorded by others.

(*c*) The marine strata in the basin—the Carrizo formation of Miocene or lower Pliocene age—are much older than the Colorado cone.

(*d*) The position of the marine strata hundreds of feet above sea-level and the fact that they are strongly

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[4] Carnegie Institution of Washington, Publication 193, p. 23, 1914.

[5] Carnegie Institution of Washington, Publication 193, pp. 25–29, 1914.

folded and beveled by erosion indicate that they were not deposited during an occupation of the present basin by the sea but in an earlier depression of considerably different form, and long before the present basin was formed.

(*e*) The strongly folded and erosionally beveled Indio formation records a long interval of continental deposition, deformation and degradation between the deposition of the underlying marine Carrizo and the development of the landscape which truncates the Indio and on which the Colorado cone—heretofore regarded as the dam which cut off the sea—was built.

(*f*) The very late date for the depression of the Salton Basin below sea-level is made the more probable by abundant evidence of recent movement in the form of very young fault scarps cutting alluvial fans and occasional earthquakes.

It might at first sight appear somewhat improbable that, in a sinking trough, the Colorado should maintain a cone now only about thirty feet above sea-level at its lowest point and yet high enough continuously to exclude the gulf out of the area sinking below sea-level to the northwest. But only two alternatives were possible if the floor of the trough sank from above to below sea-level: either the river was or was not able to upbuild its cone as rapidly as the floor subsided tectonically and to maintain it as a dam. The size of the stream, its unusually heavy burden of sediment and the 125-mile extension of the cone which it has built southward to the head of the gulf give ample ground for believing that the river would be able to cope with the sinking of the trough and maintain the dam. If any part of the cone sank, through tectonic movements, somewhat below the normal grade line of the river, which was necessarily always above sea-level, that portion would soon be built up again during one of the frequent swings of the river down the different radii of its cone.

That the salt in the bottom of Salton Basin was in all probability derived from the evaporation of Colorado River water and not from a cut-off arm of the sea has been shown by W. H. Ross.[6]

In the light of our observations and present recorded knowledge we consider it highly probable that, instead of being a cut-off and desiccated arm of the Gulf of California, the present Salton Basin sank below sea-level while the Colorado River excluded the gulf by maintaining a dam in the form of a huge alluvial cone across the southern portion of the basin.

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[6] Carnegie Institution of Washington, Publication 193, pp. 45–46, 1914.

SEX GLANDS AND ADAPTIVE ABILITY[1]

THE purpose of our investigation[2] was to determine the relation between sex glands and adaptive ability. As the first of a series of experimental reports, the present paper deals with the effect of castration upon problem box and maze performances by the white rat. The term castration is used here in its narrow sense, meaning extirpation of the testicles of male animals. It does not include ovariectomy of the female, which will form the subject of a separate experiment.

As soon as time permits, we shall attack the same general problem by studying the effects of heat, X-ray, vitamin E deficiency, testicular elevation and the ligation of vas deferens. Some of these experiments are now in progress. Besides these, we plan to study the effect of injection of testicular extracts as well as the effect of feeding interstitial tissue. These two problems will be studied along with implantation and transplantation with reference to such questions as organotherapy and rejuvenation.

The maze and the problem box were used in our experiment because they offer two widely different problematic situations to our animals and at the same time represent the best recognized technique we have in comparative psychology. White rats were chosen as our subjects. In the future, we hope to repeat our experiments on higher animals such as dogs, monkeys, etc.

Twenty-seven male rats were used in our original experiments. They were of approximately the same age and body weight. All of them had learned Maze A in an earlier experiment. Operation was performed at the age of about five months. Twelve rats had both of their testicles removed (total castration), eight had only one testicle removed (semi-castration), while the remaining seven were put through a sham operation without being castrated, that is, an operative control. Preliminary feeding was given once daily for one week, after the operation, at the center of a single-platform problem box. Six of the totally castrated rats and the seven control animals were tested in the morning, while the other six totally castrated and the eight semi-castrated ones were left for the afternoon. Each animal was confronted with the problem box situation once daily for four weeks. Bread and milk were used as the incentive. Time was the only criterion that could be employed. It was taken with a stop-watch. The results for the problem box experiment are presented in Table I.

These data on the problem box experiment justify the following statements.

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[1] Read before the Ninth International Congress of Psychology held at New Haven, Connecticut, September, 1929.

[2] The author expresses his sincere gratitude to Professor Harvey A. Carr for kind aid and interest in this research.

TABLE I

AVERAGE NUMBER OF SECONDS REQUIRED FOR SOLVING THE PROBLEM BOX

Daily average by weeks	*Morning groups*		*Afternoon groups*	
	Total castration 6 rats	Operative control 7 rats	Total castration 6 rats	Semi-castration 8 rats
First week	497	90	668	236
Second week	59	33	112	32
Third week	32	12	68	37
Fourth week	23	7.4	19	17
4 weeks Av.	153	35.6	217	80.5

(1) For the morning groups, the totally castrated rats show a poorer record than the control animals in their adaptive ability as measured by the time required to solve the problem box. The difference is very large and consistent throughout the four weeks under investigation.

(2) For the afternoon groups, the totally castrated rats show a poorer record than the semi-castrated animals in their speed of solving the problem box. The difference persists throughout the four weeks studied.

(3) The totally castrated rats of the afternoon groups show a poorer record than the totally castrated rats of the morning groups during the first three weeks, after which the difference is reversed. For a considerable time previous to the experiment, the afternoon groups were accustomed to be fed with the other groups in the morning. When the experiment began, however, it was found necessary to work on them in the afternoon. This change in their feeding habit may have been responsible for the poorer initial record of the afternoon group.

TABLE II

ORIGINAL SCORES FOR MAZE PERFORMANCE

	Mornings groups		Afternoon groups	
	Total castration 6 rats	Operative control 7 rats	Total castration 6 rats	Semi-castration 8 rats
Av. of first week—				
No. of errors	32	15.8	24	20.4
No. of retracings	18.5	6.8	11	8.7
Time in seconds	1,679.8	558.8	922.5	790.1
Av. of second week—				
No. of errors	7.3	3.3	8.1	6.4
No. of retracings	1.3	.3	.5	.4
Time in seconds	213	143	217	174
Total—				
No. of errors	39.3	19.1	32.1	26.8
No. of retracings	19.8	7.1	11.5	9.1
Time in seconds	1,892.8	701.8	1,139.5	964.1

One day after the problem box experiment, the animals were fed at the food box of Maze B for one week and trained in the maze once daily during the next two weeks. Number of cul-de-sac errors, number of retracings and time per trial were recorded. The results for maze performance are presented in Table II.

The experiment on maze performance was repeated on sixteen more animals. Eight of them were totally castrated while the other eight served as control. None of them had any previous experience with problem box or maze performance. These further results are presented in Table III.

TABLE III

FURTHER SCORES FOR MAZE PERFORMANCE

Average score for 4 weeks	Total castration 8 rats	Operative control 8 rats
No. of errors	64.4	41.7
No. of retracings	30	13.6
Time in seconds	1,873.4	1,252.2

The above data on maze performance justify the following statements.

(1) The totally castrated rats show a poorer record than the control animals in both speed and accuracy of maze performance. This difference persists throughout the two weeks tested for the morning groups of the original experiment and is also borne out by the average score for four weeks of the repeated experiment.

(2) The totally castrated rats show a poorer record than the semi-castrated animals in both speed and accuracy of maze performance. The difference persists throughout the two weeks studied.

To conclude, our data show that the totally castrated rats are inferior to the semi-castrated and the control animals in their adaptive ability as measured by the speed in solving a single-platform problem box as well as by both speed and accuracy in maze performance. As to whether the difference is due to the direct effect of the sex hormone upon the nervous system or to the change in metabolism as measured by body weight, respiratory quotient, nitrogen in the urine, etc., we shall leave for further investigation. However, Professor I. P. Pavlov's experiments, as reported at the Ninth International Congress of Psychology, on the effect of the sex hormone upon the excitability of nerve centers seem to support very strongly our first theory, namely, the direct effect of the sex hormone upon the nervous system.

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TRANSMISSION AND DIFFRACTION OF LIGHT BY NORMAL SERUM AS A FUNCTION OF THE TEMPERATURE

The present paper is a résumé of the results obtained by a further step in the systematical study of the psychochemical changes undergone by normal blood serum as a function of temperature.

We have shown previously[1] that: first, an absolute minimum of the viscosity was observed around 56° C., and that the specific viscosity increased rapidly after 58°; second, that the levo-rotatory power, unaffected by temperature up to 55° (for ten minutes' heating) increased abruptly, and that the increase, up to a certain point, was proportional to the temperature. Measurement of the amounts of light absorbed, and scattered at right angle by the molecules and particles in the serum, brought new evidence of the deep physicochemical changes which take place around 55°. The table expresses the results of one series of experiments. (Figures express the readings.)

Heated for	0	5	10	20	40	60 min.	
Temperature			52°				
Transmission	57,5	57,5	57,5	57,5	57,5	57,5	
Diffusion	125	125	125	125	125	125	
Temp.			55°				
Transmission	57,5	57,5	57,5	57,5	57,5	57,5	
Diffusion	125	125	125	125	125	125	
Temp.			57°				
Transmission	57,5	57,5	58,0	58,0	59,0	60,0	
Diffusion	125	125	117	108	95	88	
Temp.			58°				
Transmission	57,5	57,5	58,0	58,5	61,0	61,0	
Diffusion	125	122	115	105	83	83	
Temp.			60°				
Transmission	57,5	57,5	58,0	60,0	63,0	70,0	
Diffusion	125	105	96	85	75	56	
Temp.			62°				
Transmission	57,5	59,0	60,0	65,0	90,0	101,0	
Diffusion	125	95	83	65	53	46	(coag)
Temp.			64°				
Transmission	57,5	60,0	63,0	96,0	140,0		
Diffusion	125	90	73	56	48	(coag)	

In both cases (transmission and diffusion) the figures are proportional to log $\frac{I_o}{I}$, I_o being the incident light, and I the transmitted or the scattered light. In the case of scattered light, the ratio $\frac{I_o}{I}$ for a *reading of 125 is approximately equal to* $\frac{1.000.000}{1}$. This table shows plainly that, if the optical density of the solution, log $\frac{I_o}{I}$, increases slowly after 55° is reached, the same ratio decreases very rapidly when it applies to the diffracted light. (Of course, *decreasing* figures express *increases* in the amount of scattered light.)

Ten minutes' heating at 55° determines no increase in the scattered light, but ten minutes at 60° increases it roughly threefold. By applying Lord Rayleigh's formula connecting the amount of scattered light to the volume of the scattering particle, it is possible to express the increase in scattered light in terms of increased volume of the particle.

When this is done, and the data for different temperatures plotted against the time of heating, curves are obtained which show a decided tendency towards flattening when forty minutes are reached. On the contrary, if the same data are plotted against temperature, the curves are parallel and the increase in volume of particles, when the serum is heated for five, ten, twenty and forty minutes, is very nearly proportional to the temperature; *i.e.*, an increase in temperature of one degree determines about the same increase in the volume of the particle, between 57° and 64° C., whether the heating has lasted ten, twenty, forty or sixty minutes. The proportionality is rigorous within the limits of experimental errors—for a heating of ten or twenty minutes. A discrepancy is observed when the heating is kept for forty and sixty minutes. These curves are parallel to those expressing the changes in rotatory power.

One of the practical conclusions to be drawn from these findings is that the study of diffracted light affords a much more sensitive method for the study of phenomena occurring in the serum than that of transmitted light.

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[1] P. L. du Noüy, *J. Gen. Physiol.*, 1929, xii, 363; Ann. Inst. Pasteur, 1928, xlii, 742 and 1929, xliii, 749; Science, 1929, lxix, 552.

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MATHEMATICS BEFORE THE GREEKS[1]

By Professor R. C. ARCHIBALD

BROWN UNIVERSITY

OUR conceptions of Egyptian and Babylonian mathematics have been notably changed during the past fifteen years so that the third edition of the first volume of Cantor's great history is already quite out of date. Even since last March much of great interest to the student has been published. Hence it seemed both appropriate and timely for me to endeavor to present to you an accurate even though fragmentary survey of present knowledge of the mathematics of the Egyptians and Babylonians, for it is to theirs alone that I shall refer in considering mathematics before the Greeks, that is, before 600 B. C. Indeed, practically all the mathematics which I shall consider was in use before 1600 B. C.

For at least a thousand years prior to 2500 B. C. the non-Semitic Sumerians, who lived just north of the Persian Gulf and south of the Semitic Akkadians, were generally predominant in Babylonia, but were absorbed in a larger political group by about 2000 B. C. One of the greatest of the Sumerian inventions was the adoption of cuneiform script; notable engineering works of the Babylonians, by means of which marshes were drained and the overflow of the rivers regulated by canals, went back to Sumerian times, like also a considerable part of their religion and law, and their system of mathematics, except, possibly, for certain details.

Our knowledge of Babylonian mathematics is derived mainly from tablets in the British Museum, the Prussian State Museum of Berlin, the Ottoman Museum of Constantinople, the University of Strasbourg, the University of Pennsylvania and the Palais du Cinquantenaire of Brussels. Nearly thirty years ago about forty-seven mathematical problems were published in important part IX of "Cuneiform Texts from Babylonian Tablets, etc., in the British Museum" (we shall later refer to this as *CT*.IX), but so far as published material is concerned very little headway has been made in interpreting the problems.

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[1] Retiring address, as vice-president and chairman of Section A—Mathematics, of the American Association for the Advancement of Science, delivered at Des Moines, Iowa, December 30, 1929.

Our knowledge of Egyptian mathematics is gleaned chiefly from two papyri. One of these, called the Rhind papyrus, was written about 1650 B. C., but is a copy of a document which possibly dates back to 1850 B. C., and is preserved in the British Museum, except for some fragments in New York City. Three editions of this have been published: the first by A. Eisenlohr in 1877; the second by T. E. Peet in 1923, and the third by A. B. Chace, L. S. Bull and H. P. Manning in 1927–29. The last-named work contains also my survey of the literature of Egyptian and Babylonian mathematics during the past 225 years.[2] The second mathematical papyrus, called the Golenishchev Papyrus, is in the Museum of Fine Arts in Moscow and was written about 1850 B. C.; but it, too, may be a copy of an older writing of about 2000 B. C. Only five of its twenty-five problems have been published, but through the great courtesy and generosity of a Russian colleague, Professor V. V. Struve, of the Hermitage Museum in Leningrad, I have been furnished with detailed information concerning the reremaining problems of the papyrus.

The earliest dated event in history was the establishment in 4241 B. C. of the Egyptian calendar[3] of twelve months of thirty days each plus five feast days. This action implies a certain use of mathematics at this distant date. Another indication of the primitive development of Egyptian civilization is that writing was in use as early as 3500 B. C., and indeed at this date we find that the Egyptians were already in possession of the decimal system of notation. This is proved by an inscription on a great Hierakonopolis royal mace[4] now to be seen at Oxford. The inscription contains a reference to 120,000 captives and a register of captive animals, 400,000 oxen and 1,422,000 goats. In hieroglyphic writing unity is denoted by a stroke; 10 by an inverted capital U or handle; 100 by a curved rope; 1,000 by a lotus flower, very common in Egyptian fields; 10,000 by an upright bent finger; 100,000 by a tadpole, and 1,000,000 by a god with uplifted hands. Therefore 1,234,567 would be written: a god, then two tadpoles, followed by three bent fingers, followed by four lotus flowers, followed by five ropes, followed by six handles, followed by seven strokes. Such was the writing of large numbers in 3500 B. C. How much earlier was the real beginning of Egyptian mathematics? Did Egyptian and Babylonian mathematics have a common source, or were they independent in origin? It seems as if all that we can at present state with certainty is that by 2000 B. C. we find these two separate highly developed systems, that in the case of one of them a notable stage had been reached 1500 years earlier and that in the case of the other by 2400 B. C., at least, marked development had occurred.

Sumerian mathematics was essentially sexagesimal and while a special symbol for 10 was constantly used it occupied a subordinate position; there were no symbols for 100 or 1,000. One hundred was regarded as 60 + 40, 1,000 as 16.60 + 40, but in this latter case the Sumerian would simply write 16.40. So also 31.6.15 might equal 111,975. In other words, the Sumerians had a positional notation for their numbers. Their symbol for unity was also the symbol for 60, 60^2, for 60^3, etc., or for 60^{-1}, 60^{-2}, etc. Thus 31.6.15 might mean not only 111,975 but also 6,718,500, or 1866 1/4, or 31 1/10 1/240. When the unit for the first number to the right was known, the whole was determined. The uncertainty in this regard is one of the great difficulties in interpreting Babylonian mathematical texts. Within the period we are considering there was no symbol for zero but a blank space was left,[5] so that 10. .7 might stand for 36,007. In this way another element of uncertainty was introduced in interpreting these ancient writings.

While the largest fractional unit was 60^{-1}, ten of these units gave 1/6 and in ordinary calculations this occupied a central position. In early calculations there were also signs for 1/3(= 2/6); 1/2(= 3/6) and 2/3 (= 4/6), and by about 2200 B. C. there were also signs for 5/6, 1/5, 1/4. So far as our knowledge goes the Babylonians never used such complicated fractions as the Egyptians readily handled.

Babylonian multiplication tables are very numerous and are almost always the products of a certain number successively by 1, 2, 3 . . . 20, then 30, 40 and 50. For example, on tablets of about 1500 B. C. at Brussels[6] are tables of 7, 10, 12½, 16, 24, each multiplied into such a series of numbers. There are various tablets giving the squares of numbers[7] from 1 to 50, and also the cubes, square roots and cube roots of numbers. But we must be careful not to assume too much from this statement; the tables of square roots and cube roots were really exactly the same as tables of squares and cubes, but differently expressed.[8] In the period we are considering the Egyptian really had nothing to correspond to any of these tables, nor do we know that even the conception of cube root was within his ken. There are also tablets exhibiting the process of division: 60 by its integral factors[9] and 12,960,000 (according to one interpretation) by some of its factors.[10] In connection with one of these latter tablets we find two series of numbers in geometric progression 125, 250 . . . , 16,000; 810, 1620 . . . , 103,680. We shall later refer to another series of numbers in geometric progression 5, 10 . . . , 80 found in an Akkadian tablet of the seventh century B. C. Sumerian multiplication tables would, of course, give numbers in arithmetic progression.

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[2] In the course of the following foot-notes "Bibliography" will refer to this survey.

[3] J. H. Breasted, "Ancient Times," Boston, 1916, p. 45.

[4] J. E. Quibell, "Hierakonopolis," pt. 1, London, 1900, plate 26B.

[5] The sign replacing the blanks seems to have been first used about 250 B. C.; see the copy of a British Museum tablet in F. X. Kugler, "Die Babylonische Mondrechnung," Freiburg-i-B., 1900, plate 5, l. 26, sign, 3, l. 88, sign 3, l. 89, sign 8, etc.

[6] L. Speleers, "Recueil des Inscriptions de l'Asie Antérieure des Musées Royaux du Cinquantenaire à Bruxelles," Brussels, 1925, p. 29, 94–95. In the University of Pennsylvania there are twenty-three tablets containing multiplication tables, in part or complete, and dated for the most part about 1300 B. C.; but a few are dated 2000 B. C. The multipliers are such numbers as: 2, 6, 9, 18, 30, 36, 90, 432, 450, 540, 960, 1080, 2160; see H. V. Hilprecht, "Mathematical, Metrological and Chronological Tablets," Philadelphia, 1906, p. 57–61, 68–69. See also British Museum, "A Guide to the Babylonian and Assyrian Antiquities," third ed., London, 1922, p. 161.

But turning from such tables to arithmetic calling for their application we find that long before coins were in use the custom of paying interest for the loan of produce, or of a certain weight of a precious metal, was common. Sumerian tablets indicate that the rate of interest varied from 20 per cent. to 30 per cent., the higher rate being charged for produce. At a later period the rate was $5\frac{1}{2}$ per cent. to 25 per cent. for metal and 20 per cent. to $33\frac{1}{3}$ per cent. for produce.[11] An extraordinary number of tablets show that the Sumerian merchant of 2500 B. C. was familiar with such things as weights and measures, bills, receipts, notes and accounts.

The study of the weights and measures of the Babylonians seems especially important for clearly understanding their mathematics, as Neugebauer, building on work of Thureau-Dangin and others, has recently argued.[12] But time will not permit me to discuss this topic or the large subject of the metrology of the Egyptians.[13]

Let us now consider some characteristics of Egyptian mathematics. We have remarked that tables such as a Babylonian used were not part of an Egyptian's equipment. He did use other tables, however, which dealt with the fundamental feature of his arithmetic, namely, the expression in terms of two or more unit fractions of (*a*) one unit fraction,[14] *e.g.*, $1/7 = 1/14\ 1/21\ 1/42$; (*b*) 2 divided by an odd number,[15] and (*c*) other quotients,[16] as $3 \div 10 = 1/5\ 1/10$; for, with the single exception[17] of 2/3, the Egyptian had no notation for other fractions. After the title page of the Rhind papyrus, more than a quarter of the written part of the papyrus is occupied with a table expressing in this way 2 divided by the various odd numbers 5 to 101 inclusive. For example, $2:7 = 1/4 + 1/28$,

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[7] For example, in the University of Pennsylvania, dating from about 1300 B. C.; see Hilprecht, "Mathematical, Metrological and Chronological Tablets," Philadelphia, 1906, p. 69, and plate X. See also British Museum, "A Guide to the Babylonian and Assyrian Antiquities," third ed., London, 1922, p. 161.

[8] The two tablets with square roots in the University of Pennsylvania date from about 2000 B. C.; see Hilprecht, *ibid*, p. 62–63, and pl. 16. A tablet in the British Museum dating from about 1900 B. C. and containing tables of square roots and cube roots is described in F. Lenormant, "Essai sur un document mathématique chaldéen," Paris, 1868 (for further references in this connection see my Bibliography). For a tablet with squares, cubes, etc., of a given number see British Museum, "A Guide to the Babylonian . . . ," 1922, p. 161. See also M. Cantor, "Babylonische Quadratwurzeln und Kubikwurzeln," *Zeitschrift für Assyriologie*, 21: 110–115, 1908.

To illustrate arithmetical operations of about 2000 B. C. a quotation may be made from a problem on a tablet transcribed by C. Frank, "Strassburger Keilschrifttexte in sumerischer und babylonischer Sprache," *Schriften der Strassburger Wissenschaftlichen Gesellschaft in Heidelberg*, n.s., Berlin, 1928, Heft 9, p. 21: " . . . the square of 13.20 is 2.57.46.40. Add 2.57.46.40 to 50.33.20. It is 53.31.6.40. The square root of 53.31.6.40 is 56.40."

[9] A Tello tablet of about 2200 B. C. in Constantinople; no. M. I. O. 7375 in vol. 3 of "Inventaire des tablettes de Tello." (See also L. Delaporte, *Revue d'Assyriologie*, 8: 131–133, 1911.)

[10] Four tablets of about 2000 B. C. in the University of Pennsylvania; see Hilprecht, "Mathematical . . . ," p. 61–62, pls. 10, 12, 14, 15. While the tablets exhibit divisions, it is not certain that the dividend is 12,960,000, which Hilprecht called the geometric number of Plato. The literature of this topic is extensive. See, for example, A. G. Laird, "Plato's Geometric Number and the Comment of Proclus," Madison, 1918.

[11] M. Jastrow, Jr., "The Civilization of Babylonia and Assyria," Philadelphia, 1915, p. 326, 338; C. H. W. Johns, "Babylonian and Assyrian Laws, Contracts and Letters," New York, 1904, p. 251, 255–256. See also D. E. Smith, "History of Mathematics," vol. 2, 1925, p. 560.

[12] O. Neugebauer, "Zur Entstehung des Sexigesimalsystems," Gesellschaft der Wissenschaften zu Göttingen, *Abhandlungen math.-phys. Klasse*, n.s. vol. 13, no. 1, 1927; Thureau-Dangin, Numération et métrologie sumeriennes," *Revue d'Assyriologie*, 18: 123–142, 1921.

[13] A source of fundamental importance is F. L. Griffith, "Notes on Egyptian Weights and Measures," Society of Bibl. Archaeology, *Proceedings*, 14: 403–450, 1892; 15: 301–315, 1893.

[14] For example in a document of about 1650 B. C., Leather roll, B.M. 10250, *Journal of Egyptian Archaeology*, 13: p. 232–238, 1927, + plates; article by S. R. K. Glanville.

[15] As in the Rhind Papyrus of about 1650 B. C.

[16] See, for example, the table of the divisions of the numbers 1–9 by 10 in the Rhind papyrus; for a table 2000 years later see H. Thompson, "A Byzantine Table of Fractions," *Ancient Egypt*, 1914, p. 52–54.

[17] Compare K. Sethe, "Von Zahlen und Zahlworten bei den alten Ägyptern," (*Schriften der wissenschaftlichen Gesellschaft in Strassburg*, Heft 25), Strasbourg, 1916; it is here made clear (p. 94) that the sign for 2/3 did not, at least in its original form, suggest that 2/3 was thought of as $1/1\frac{1}{2}$.

2 ÷ 97 = 1/56 + 1/679 + 1/776, and both of these results as well as 2/3 = 1/2 + 1/6 are used in the course of the solution of the thirty-first, of about eighty problems[18] of the papyrus following the table. In these illustrations from the table, 2 divided by an odd number is expressed in terms of the sum of either two or three unit fractions. But four unit fractions are given in eight of the forty-nine divisions. The last of these, 2 ÷ 101 = 1/101 + 1/202 + 1/303 + 1/606, is interesting for two reasons: (1) because we first learned of it in 1923 through papyrus fragments discovered in New York City, and (2) because this is the *only* case of this table where a unit fraction has the same denominator as that of the fraction being resolved. All sorts of conjectures have been made, and theories formulated, as to how the author of the papyrus came to select out of the infinite number of possibilities in this table the particular sets given. These discussions include a very elaborate monograph and two doctoral dissertations, one of them appearing less than two months ago at the University of Munich and containing nearly 220 pages.[19]

The form of this table of 2 divided by an odd number is often merely a verification by multiplication and addition of the result stated. For example, in connection with the relation already referred to 2 ÷ 97 = 1/56 + 1/679 + 1/776, 97 is multiplied by 1/56 to give 1 1/2 1/8 1/14 1/28; 1/679 of 97 is 1/7; 1/776 of 97 is 1/8. The sum of these products or quotients is 2 as it should be. Now how did the Egyptian arrive at these results? In the case of 1/776 of 97 he would consider what number multiplied by 97 gives 776 and he would multiply 97 successively by 2 thus:

1	97
2	194
4	388
\8	776

from which it follows that the 97 ÷ 776 = 1/8. So also for 97 ÷ 679; for on adding 4 and 2 and 1 times 97, we find that 7 times 97 gives 679. In the case of 97 ÷ 56 the Egyptian would inquire what was the result of taking 1/56 of 97; we may proceed by inquiring what number we would multiply 56 by in order to get 97. The work would be as follows:

\1	56
\1/2	28
1/4	14
\1/8	7
\1/14	4
\1/28	2

from which we see that the multiplier of 56 which gives 97 is 1 1/2 1/8 1/14 1/28. (The check marks which I have used were employed in exactly the same way by the Egyptian.) Let us consider one other example to illustrate further points in multiplication. Suppose the Egyptian were asked to find what parts of 105 loaves will make 82 he might seek multipliers of 105 to give[20] 82. Thus:

1	105
\2/3	70
1/3	35
1/30	3½
\1/15	7
1/10	10½
1/5	21
\1/21	5

Total 2/3 1/15 1/21

To sum up, problems of division are reduced to those of multiplication; multiplication of two numbers is carried through by successive multiplications of one of the numbers by twos or tens or by 2/3, or by divisions of the number by twos or tens. The further extraordinary fact is revealed that in order to get 1/3 of any number, the Egyptian frequently first found the value of 2/3 of the number, and then halved the result. This is illustrated repeatedly in the Rhind papyrus.[21] It would seem as if the Egyptian had specialized in the technique of taking 1/1½ of any number,[22] or used tables for this purpose.[23]

There are only two general rules in the Rhind papyrus; one of these is in problem 61 for finding 2/3 of the reciprocal of an odd number. The rule is as follows: "To get 2/3 of 1/5 take the reciprocals of 2 times 5, and 6 times 5; and in the same way get 2/3 of the reciprocal of any odd number." This rule is applied several times[24] in the papyrus; the remarkable application in problem 33 gives 2/3 of 1/679 = 1/1358 1/4074.

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[18] For convenience in reference Eisenlohr introduced nos. 1–87 for referring to different parts of the Rhind papyrus, just as Struve uses nos. 1–25 for the Golenishchev papyrus. But numbers 85–87, and some of the others, are not problems.

[19] See Lepsius (1865), Loria (1892), Bobynin (1890, 1899), Cantor (1880), Mansion (1888), Hultsch (1895, 1901), Neugebauer (1926), Gillain (1927, 1928), Vogel (1929), and other references in my Bibliography.

[20] Compare problems 21 and 22 of the Rhind papyrus.

[21] For example, problems 8, 16–20, 25, 29, 32, 38, 42, 43, and 67. See the Chace edition of the Rhind papyrus, vol. I, p. 4, where Gunn's view to the contrary is refuted.

[22] That 1/1½ of a number is equivalent to 2/3 of that number is illustrated in problem 33. So also in problem 19 of the Golenishchev papyrus; but possibly this last reference may be quoted in support of Gunn's view that to get 2/3 of a number, 1/3 of that number was first found.

[23] It seems probable that such a table was given in a Byzantine table of fractions studied by Thompson, *Ancient Egypt*, 1914; see K. Sethe, "Von Zahlen und Zahlworten bei den alten Ägypten," Strasbourg, 1916, p. 70.

The second general rule is indicated in connection with problem 66: "If 10 hekat of fat are given out for a year, what is the amount used in a day?" The year is taken as containing 365 days and since there are 320 ro in one hekat, the problem is reduced to finding how many times 365 is contained in 3200 and the answer is found to be 8 2/3 1/10 1/2190 ro. The general rule then follows: "Do the same thing in any example like this."[25]

To illustrate other interesting points let us consider problem 33 of the Rhind papyrus: "A quantity, its 2/3, its 1/2 and its 1/7 added together become 37. What is the quantity?"[26] We would now naturally solve this as a simple equation in algebra $x(1+2/3+1/2+1/7)=37$ and find $x=16\ 2/97$. The Egyptian asked himself what number multiplied into 1 2/3 1/2 1/7 gives 37. By manipulation illustrated above, he soon finds that $16(1+2/3+1/2+1/7)=36\ 2/3\ 1/4\ 1/28$ which is less than the 37 he wants by an amount which he proceeds to determine in using 42 as a comparison number. Taking 2/3 1/4 1/28 of 42, he gets 40 there remains 2; in other words 2/3 1/4 1/28 differs from 1, which was necessary to add to 36 in order to give 37, by 1/21. The author then shows that 1 2/3 1/2 1/7 applied to 42 gives 97 and hence knows that 1/97 of 1 2/3 1/2 1/7 is 1/42; whence, multiplying this result by 2, he gets $2 \div 97$ or 1/56 1/679 1/776 of 1 2/3 1/2 1/7 is equal to 1/21. Hence he has as answer 16 1/56 1/679 1/776.

By my method of presentation I have tried to indicate that in use of a comparison number 42 the Egyptian did not necessarily think of fractions other than unit fractions, although we might say that his operation was ***equivalent to*** bringing to a common denominator. The question comes up again in vastly more complicated form when he proves that the result he has got is correct. After writing down the products

1	16 1/56 1/679 1/776
2/3	10 2/3 1/84 1/1358 1/4074 1/1164
1/2	8 1/112 1/1358 1/1552
1/7	2 1/4 1/28 1/392 1/4753 1/5432

he proceeds to prove that the sum of his products is 37 and makes use of the comparison number 5432.

The question as to whether the Egyptian had a *conception* of the general fraction has been the topic of much discussion. Sethe believed that he did not;[27] but Peet[28] and Wieleitner[29] hold to a contrary view. By excessively brief suggestion I have attempted to present the somewhat original view set forth in the Chace edition of the Rhind papyrus.

One is tempted to dwell on some other Egyptian problems which we might solve by simultaneous equations. Turning to the Rhind papyrus, we may consider problem 40, which we would naturally solve with two linear simultaneous equations. The problem is as follows: "Divide 100 loaves among 5 men in such a way that the shares received shall be in arithmetical progression and that 1/7 of the sum of the largest three shares shall be equal to the sum of the smallest two. What are the shares?" The solution starts in at once: "Do it thus: Make the difference of the shares 5 1/2. Then the amounts the five men receive will be 23 17½ 12 6½ 1, total 60. As many times as it is necessary to multiply 60 to make 100, so many times must these terms be multiplied to make the true series, and it is found that 1 2/3 times 60 make 100 and hence the shares 38 1/3, 29 1/6, 20, 10 2/3, 1 2/3. The use of proportion here is especially interesting.[30] For the very attractive method by which the Egyptian probably arrived at the difference 5 1/2 on assuming that one man's share was 1, see Chace's edition of the papyrus. The problem is notable also as illustrating that while the Egyptian did not consider such things as simultaneous equations, he was nevertheless able in certain cases to obtain the result by methods at his command.

Problem 64 is another one involving an arithmetic progression[31]: "Distribute 10 hekat of barley among 10 men in such a way that the shares shall be in arithmetical progression with a common difference of 1/8 hekat. What is the share of each?"[32]

Problem 79 seems to be as follows: "In each of 7 houses are 7 cats, each cat kills 7 mice, each mouse would have eaten 7 ears of spelt, each ear of spelt will produce 7 hekat of grain; how much grain is thereby saved?" But the author gives only the sum of the five terms of the geometric progression of which the first term is 7 and the multiplier 7. The proof which he gives has been the subject of speculation as to whether the Egyptian knew of a certain general relation in connection with geometric series; but it has recently become clear[33] that *nothing* but multiplication is here involved. The problem is of interest from another point of view. In a thirteenth century work of Leonardo of Pisa the following problem occurs[34]: "7 old women invaded Rome; each woman had 7 donkeys; each donkey carried 7 sacks; each sack contained 7 loaves of bread; with each loaf were 7 knives; each knife was in 7 sheaths? What is the total?" The persistence of this type of problem after twenty-eight centuries is notable. Even in our own day we have: "As I was going to St. Ives I met a man with 7 wives; each wife had 7 sacks; each sack had 7 cats; each cat had 7 kits; kits, cats, sacks and wives, how many were there going to St. Ives?"

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[24] Rhind Papyrus, problems 17, 30, 33, 61.

[25] Compare the Latin, ''*Fac ita,*'' and the early German, ''*Thu ihm also.*''

[26] This problem is exactly the same as problem 31, if 33 is substituted for 37.

[27] K. Sethe, (*a*) ''Von Zahlen und Zahlworten bei den alten Ägyptern,'' Strasbourg, 1916, p. 62; (*b*) ''Deutsche Mathematiker-Vereinigung,'' *Jahresbericht*, 33: 141, 1925.

[28] T. E. Peet, ''Rhind Papyrus,'' p. 16–17.

[29] H. Wieleitner, ''Kannten die Ägypter den Begriff eines allgemeinen Bruches?'' *Mitteilungen zur Geschichte der Medizin und der Naturwissenschaften*, 25: 1–4, 1926.

[30] Problem no. 7 of the Golenishchev papyrus contains a special word for ratio; compare Peet, p. 60.

[31] A third Egyptian problem involving an arithmetic progression is in the Kahun Papyri of about 1850 B. C.; see F. L. Griffith, ''The Petrie Papyri. Hieratic Papyri from Kahun,'' 2 vols., London, 1897–98 (see Bibliography).

[32] I have given a new solution of this problem in *Isis*, December, 1928, 11: p. 397 (in line 12 of this page *for* ''shares 8'' *read* ''share,'').

No sketch of Egyptian mathematics should fail to refer to the process of false position which was so freely used[35] and which has been employed through the centuries even down to our arithmetics of a generation ago. The method consists in assuming a certain numerical answer and then, by performing the operations of the problem, arriving at a number, which can be compared with a given number, the true answer having the same relation to the assumed answer that the given number has to the number thus obtained. Consider an example. In problem 27 it is required to find a quantity such that it and its 1/5 added together become 21. In the solution 5 is assumed for the quantity then the quantity and its 1/5 make 6. As many times as 6 must be multiplied to give 21, so many times must 5 be multiplied to give the required number. It is found that 6 had to be multiplied by 3½; hence the required number is 5 multiplied by 3½ or 17½.

In concluding these references to various arithmetic operations and processes it should be noted that the idea of squaring a quantity was not unknown to the Egyptian. This is indicated by its use in problems 11 and 14 of the Golenishchev papyrus. So also for the square root of a number, for which a special sign is used in problems 6, 7 and 17 of the Golenishchev papyrus, in one of the Kahun papyri,[36] and in Berlin papyrus 6619,[37] all three dating from about 1850 B. C. The square roots of integers are found in all but the two examples of the Berlin papyrus, where the square roots of 6 1/4 and of 1 1/2 1/16 are given.

But there are other problems not so interesting for their mathematics as for other things. For example, problem 67 of the Rhind papyrus starts out in this way: "The herdsman came to the stock-taking with 70 cattle. The accountant said to the herdsman, Very few tribute-cattle art thou bringing; pray where are all thy tribute cattle? The herdsman replied to him, What I have brought is 2/3 of 1/3 of the cattle that thou hast committed to my care. Count and thou wilt find the full number." In this way it appears that 70 out of 315 cattle were levied by the owner as tribute.

Problem 62 is as follows: "Example of reckoning the contents of a bag of various precious metals. Suppose it is said to thee, A bag containing equal weights of gold, silver and lead has been bought for 84 rings. What is the amount in it of each precious metal, that which is given for a deben of gold being 12 rings, for a deben of silver 6 rings and for a deben of lead 3 rings?"

The feed for geese, cranes, ducks, quails, doves, also for bulls and common cattle, is discussed in problems 82–84. In the Golenishchev papyrus is the following rule-of-three: Problem 23: "A sandal maker works for 15 days receiving wages every five days. If he does the work in 10 days after what periods should he be paid?"

Then, too, 10 of the 25 problems in the Golenishchev[38] and 10 of about 80 in the Rhind [39] papyrus are so-called pefsu, or cooking ratio, problems. Pefsu is the number of units of food or drink that could be made from a unit of material in the process of cooking, and it determined the relative value of any food or drink; the lower the pefsu, the more valuable the unit of food. A couple of enunciations only may be given in illustration: (*a*) Rhind, no. 69, "3½ hekat of meal are made into 80 loaves of bread. Let me know the amount of meal in each loaf and what is the pefsu." (*b*) Rhind, 78, "Suppose it is said to thee, 100 loaves of pefsu 10 are to be exchanged for a quantity of beer of pefsu 2. How many des of beer will there be?"

Any survey of the mathematics of the Egyptians ought to include at least a brief reference to one of their extraordinary monuments, the great pyramid at Gizeh, erected during the reign of Cheops about 2900 B. C. The mere fact that the erection of such a structure was possible indicates a very remarkable governmental and social organization. It is said that 100,000 workmen were kept constantly employed on this structure for fifty years, ten years of this period being used in constructing a road to the limestone quarry some miles distant. It has been estimated that over this road were brought 2,300,000 blocks of stone averaging two and one half tons in weight. These blocks were fitted together very perfectly. For the roofs of chambers granite blocks twenty-seven feet long, six feet high and four feet thick, and weighing some fifty-four tons each, were brought from the quarry over 600 miles away and conveyed by a brick ramp to their position over 200 feet above the ground level. The pyramid covered about thirteen acres and recent surveys show[40] that its base was almost a perfect square, no side differing from the mean length of 755.78 feet by more than 4½ inches, while two of its angles differ from 90° by less than 34 seconds, and the other two by less than 3½ minutes.[41] The orientation of a side of the square being almost exactly north and south was an indication not only of careful observations of the stars by the Egyptians but also of astrological considerations, so prevalent in those days. The height of the pyramid was about 481 feet, and there were various passage ways to the chambers within the structure. Especially since the publications of John Taylor in 1859 and 1864, and of C. Piazzi Smyth, astronomer royal for Scotland, in 1864 and 1867, even down to 1929, all sorts of curious pyramid mysticism has been the subject of discussion in scores of chapters, articles, pamphlets and books.[42] In connection with the pyramid of Gizeh such mysticism has led to conclusions like the following being regarded as gospel: (1) it was built in the present proportions so that the perimeter of its base should be exactly equal to the perimeter of a circle of which the pyramid's height was radius; (2) the perimeter of the base was so chosen that it might contain one hundred times as many pyramid inches as there are days in the year; (3) the pyramid inch is equal to a five hundred millionth part of the earth's polar diameter; (4) the total area is divided in golden section, that is, the area of the base is to the sum of the areas of the faces as this sum is to the sum of the areas of the faces and base; (5) it was intentionally placed exactly in latitude 30°.

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[33] O. Neugebauer, "Die Grundlagen der ägyptischen Bruchrechnung," Berlin, 1926, p. 14–15.

[34] Leonardo of Pisa, "Scritti," vol. 1, Rome, 1857, p. 311–312.

[35] For example in problems 24–27, 35, 37, 38 of the Rhind papyrus; also in 40 which we have already discussed.

[36] F. L. Griffith, "The Petrie Papyri. Hieratic Papyri from Kahun and Gurob," vol. 2, plate VIII.

[37] H. Schack-Schackenburg, *Zeitschrift für ägyptische Sprache*, 38: 138, 1900; 39: 65, 1901.

[38] Nos. 5, 8, 9, 12, 13, 15, 16, 20, 22, and 24.

[39] Nos. 69–78.

Had De Morgan lived a few years longer his recreation of crushing circle-squarers might well have been set aside for plaguing pyramiders.

But the problems of mechanics and engineering involved in handling even the larger stone blocks of the pyramids were slight as compared with those dealt with by Egyptians in quarrying and setting up some of their huge obelisks[43] of pink granite. The largest existing obelisk, quarried about 1500 B. C., was no less than 105 feet long, nearly ten feet square at the larger end and about 430 tons in weight. It was set up in front of the Temple of the Sun at Thebes, but moved, about 1,800 years later, to the piazza of St. John Lateran at Rome, where it may be seen to-day.

But another extraordinary fact to be noted, concerning the engineers or surveyors contemporary with the pyramid and obelisk builders, is that they were already in possession of methods for laying out nilometers around innumerable bends in the river Nile for a distance of seven hundred miles such that the zero points of the nilometers, always below lowest water, are all in one plane.[44]

Let us now turn from applied to results which we usually associate with pure mathematics and consider the geometry of the Babylonians and Egyptians.

BABYLONIAN GEOMETRY

One of the most interesting of Babylonian tablets was found at Tello, Arabia, and is now in the Ottoman Museum at Constantinople. It dates back to about 2200 B. C. and was first described in 1896 by Eisenlohr[45] and Oppert,[46] and later by Thureau-Dangin.[47] It is the plan of a great field divided into 15 parts: 7 right triangles, 4 rectangles (nearly) and 4 trapezia[48] (one side always perpendicular to the parallel sides). The lengths of the lines and the areas of the parts which are indicated show that the following geometrical results, probably derived wholly empirically, were known at that time:

1. The area of a rectangle is the product of the lengths of two adjacent sides.

2. The area of a right triangle is equal to one half the product of the lengths of the sides about the right angle.

3. The area of a trapezium with one side perpendicular to the parallel sides is one half the product of the

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[40] I. H. Cole, "Determination of the Exact Size and Orientation of the Great Pyramid of Giza," Survey of Egypt, Paper no. 39, Cairo, 1925; L. Borchardt, "Längen und Richtungen der vier Grundkanten der grossen Pyramide bei Gise," Berlin, 1926.

[41] The results quoted by J. H. Breasted in this connection (*Scientific Monthly*, 10: 92, 1920) have since been found to be incorrect.

[42] Particularly under 1854, 1910, and 1928 (Suppl) in my Bibliography are some sample titles in this field. See also Borchardt's pamphlet listed under 1922.

[43] A recent valuable work devoting considerable space to the mechanics of setting up obelisks is "The Problem of the Obelisks from a Study of the Unfinished Obelisk at Aswan," London, 1923, by R. Engelbach, an Englishman who is director of the Egyptian Museum at Cairo.

[44] J. H. Breasted, *Scientific Monthly*, 10: 91, 1920. See also L. Borchardt, "Nilmesser und Nilstandsmarken," Berlin, 1906 (in Preuss. Akad. d. Wissenschaften, *Abhandlungen*).

[45] A. Eisenlohr, *Ein altbabylonischer Feldplan*, Leipzig, 1896.

[46] J. Oppert, Académie d. Inscriptions et Belles-Lettres, *Comptes Rendus*, s. 4, v. 24, 1896, p. 331–348; also in *Revue d'Assyriologie et d'Archéologie Orientale*, v. 4, 1897, p. 28–33.

[47] F. Thureau-Dangin, *Revue d'Assyriologie*, v. 4, 1897, p. 13–27.

[48] The meaning of the terms "trapezium" and "trapezia" of this paper is that used in every country of the world except the United States.

length of this perpendicular and the sum of the lengths of the parallel sides.

For the history of the Pythagorean theorem a portion of an Akkadean tablet in the Prussian State Museum, dating back to about 2000 B. C., is of special interest. It was published by Weidner[49] in 1916. The figure of a rectangle with one diagonal is drawn and the dimensions of the rectangle, 10, "breadth," and 40, "height," are given. Two methods are used to calculate the length c of the diagonal. The first method leads in numbers to the approximation $c = a + 2ab^2.60^{-2}$, where a is the length of the greater side and b of the lesser. The text of the solution here translated freely is as follows:

> Square the side of length 10 then thou will get 1 · 40 $[60 + 40 = 100]$. The square area 1.40 [100] multiplied by the length 40 of the other side gives thee 1.6.40 $[1 \cdot 60^2 + 6 \cdot 60 + 40 = 4000]$. In doubling thou wilt get 2.13.20 $[2 \times 62^2 + 13 \cdot 20 = 8000]$ adding that to 40 thou wilt get 42.13.20 $[42 + 13 \cdot 60^{-1} + 20 \cdot 60^{-2}]$ as diagonal. Such is the calculation.

The second method seems to lead in numbers to the relation $c = a + b^2/2a$ which is what one arrives at in the calculation of $(a^2 + b^2)^{1/2}$ if terms after the second are neglected. The result found here is $41 + 15.60^{-1}$. How were the Akkadians led to such formulas? It is not possible to believe that in the case of the second approximation they thought of anything like a binomial expansion which we find natural, even though Hilprecht be correct in thinking that they were familiar with the expansion[50] $(a + b)^2 = a^2 + 2ab + b^2$. Rather are such approximations remarkable developments to meet needs, as we observe in other directions, in connection with these extraordinary people.

This tablet suggests that the Babylonians may have known the Pythagorean theorem for a right triangle. This appears to be a certainty when we consider two among forty-seven mathematical problems in *CT*.IX. It was less than nine months ago, in a paper by Struve and Neugebauer,[51] that the meaning of these two problems became clear. In the first of these problems we are given the length 60 of the circumference of a circle and the length 2 of a perpendicular from the center of a chord of the circle to the circumference; it is required to find the length of the chord. If d denotes the length of the diameter of a circle, s the length of a chord and a the height of the arc corresponding to this chord then

$$s = [d^2 - (d - 2a)^2]^{1/2}.$$

The various operations in the solution of the problem seem definitely to prove that the equivalent of this relation was familiar to the Babylonians of 2000 B. C. The text is as follows:

> 1 [= 60] the circumference, 2 the perpendicular, to find the chord. Do as follows, square 2, thou seest it is 4. Subtract 4 from the diameter 20 thou seest it is 16. Square the diameter 20 thou seest it is 6.40 [= 400]. Square 16 thou seest it is 4.16 [= 256]. Subtract 4.16 from 6.40 giving 2.24 [= 144] of which calculate the square root. The square root is 12. Such is the procedure.

This solution brings out, what may be checked in other parts of *CT*.IX, that 3 was the value of π used by the Babylonians. It will be recalled that this was the value we find in the Bible, for example, in I Kings 7: 23, which was written about 560 B. C. and may have been taken from temple records dating back to 900 B. C. This verse is as follows: "And he made a molten sea, 10 cubits from one brim to the other: it was round all about, and his height was 5 cubits and a line of 30 cubits did compass it round about." We note also that the proposition of Thales of Miletus that the angle in a semi-circle is a right angle was visualized by the Babylonians 1,400 years earlier, and that a study was made of chords of a circle long before the days of Hipparchus.

The second problem in *CT*.IX to which we have referred is to find a given $d = 20$ and $s = 12$; each step is equivalent to substitution in the formula

$$a = 1/2[d - (d^2 - s^2)^{1/2}].$$

Other results in *CT*.IX are: (*a*) The area of a circle is one twelfth the square of the length of its circumference; (*b*) the volume of the frustum of a cone is one half the sum of the areas of the circular bases times the distance between them.

Another series of problems of great mathematical interest is found on tablets of about 2000 B.C. in the library of the University of Strasbourg. These were published with a translation in 1928 by Carl Frank[52] and their meaning was ingeniously elaborated this year by Neugebauer.[53] The problems treat of various sections of a right triangle by lines drawn parallel to the base, which is regarded as horizontal, the vertex being below the base. In problem 10, two lines are drawn parallel to the base and the figure consisting of the two adjacent trapezia is considered. The area of the upper trapezium is given as 783, of the lower as 1,377. The difference of the base (b) and the lower dividing line (d_2) is given as 36. It is also given that the difference between the base and the upper dividing line (d_1) is one third of the difference between the upper and lower dividing line. It is required to find five unknown quantities: the lengths of the base and of the two dividing lines, and the altitudes of the trapezia (h_1 and h_2). The various statements above lead us to the following relations: $(1/2)h_1(d_1+b)=783$; $(1/2)h_2(d_2+d_1)=1377$, $b-d_2=36$, $b-d_1=(1/3)(d_1+d_2)$. It follows from this last equation and from similar triangles that $h_2=3h_1$, and from these five relations between five unknown quantities it is found that $b=48$, $d_1=39$, $d_2=12$, $h_1=18$, $h_2=54$. The mere formulation of such a problem gives a striking impression of the mathematical capabilities of the Babylonians. Neugebauer seems to have thought that as a result of this problem we might say that they knew how to solve five equations in five unknown quantities. To me such a suggestion is highly misleading; the much more natural deduction is that the Babylonians had developed considerable insight into geometrical relations (further examples of this might be shown[54] if time permitted), and solved the problem entirely from geometrical considerations. This would imply, in particular, that they were familiar with the result that similar right triangles have the sides about the right angles proportional, a theorem which our mathematical histories connect with Thales.

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[49] E. F. Weidner, "Die Berechnung rechtwinkliger Dreiecke bei den Akkadern um 2000 v. Chr.," *Orientalestische Literaturzeitung*, v. 19, 1916, cols. 257–263; see also commentary by A. Ungnad, cols. 363–368, and by H. Zimmern, cols. 321–325. A reference may be given also to O. Neugebauer, "Zur Geschichte des Pythagoräischen Lehrsatzes," Gesellschaft der Wiss. zu Göttingen, *Math.-phys. Kl., Nachrichten*, 1928, p. 45–48.

[50] H. V. Hilprecht, "Mathematical, Metrological and Chronological Tablets from the Temple Library of Nippur," Philadelphia, 1906, p. 24.

[51] O. Neugebauer and W. Struve, "Über die Geometrie des Kreises in Babylonien," *Quellen und Studien zur Geschichte der Mathematik, Abteilung B: Studien*, Berlin, 1929, p. 89–92.

[52] C. Frank, "Strassburger Keilschrift Texte in sumerischer und babylonischer Sprache," Strassburger Wissenschaftlichen Gesellschaft in Heidelberg, *Schriften*, n.s., part 9, Berlin and Leipzig, 1928.

[53] O. Neugebauer, "Zur Geschichte der babylonischen Mathematik," *Quellen und Studien zur Geschichte der Mathematik, Abt. B, Studien*, v. 1, 1929, p. 67–80.

In another problem a right triangle is divided into five parts by four lines drawn parallel to the base, and from certain data other parts are to be found. In yet another, a triangle is divided into two parts (a trapezium and a triangle) by a single dividing line (of length d) parallel to the base, which is given as 30 units in length. The altitude of the triangle is given as 10 units greater than h_1, the altitude of the trapezium, and the area of the triangle is given as 270. Whence $270=(1/2)d(h+10)$; making use of the result regarding similar right triangles referred to above, we would have also $d:(h+10)=30:(2h+10)$ from which, according to methods of to-day, we would be naturally led to a quadratic equation for determining h. Neugebauer notes two other similar problems the discussion of which leads to quadratic equations whose solution is called for by the problem. It is exactly in connection with these questions, however, that details as to the solutions of the questions are lacking. Were it not for a note at the end of the article we might incline to regard the introduction of quadratic equations as out of keeping with the mathematics discussed. In this note, however, Neugebauer states that in another problem of *CT*.IX the discussion leads to the quadratic equation

$$x^2-\frac{2F}{d}x+\frac{2Fh}{d}=0$$

and that the solution follows step for step by substitution in the formula:

$$x=\frac{F}{d}-\left[\left(\frac{F}{d}\right)-\frac{2Fh}{d}\right]^{\frac{1}{2}}.$$

In an article published last August Wieleitner reported[55] that he had inspected an unpublished manuscript of Neugebauer and was thoroughly convinced by the evidence adduced that the Sumerians of 2000 B. C. understood how to solve problems which led to a general quadratic equation—a new fact of very extraordinary interest. It was previously supposed that Heron of Alexandria who flourished about 250 A. D. was the first to use our modern method of solving a quadratic equation.[56]

Although more a matter connected with astronomy, we may possibly under the head of geometry consider the Babylonian divisions of a circle. Bosanquet and Sayce stated[57] with great definiteness that the divisions which are found are those into 8, 12, 120, 240 and 480 parts; that we do *not* find the division into 360 parts as commonly supposed; and that while the division of the circle as practiced by Ptolemy and in modern times is an outgrowth of the sexagesimal method of the inscriptions, the latter does not contain the former. In support of his argument the authors quote an Akkadian tablet[58] in the British

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[54] For example, see C. J. Gadd, "Forms and Colours," *Revue d'Assyriologie et d'Archéologie Orientale*, 19: 149–158, 1922. The article is mainly descriptive of a British Museum tablet of about 2000 B. C. on which are drawn about a dozen figures involving squares and arcs of circles. At least two of the figures suggest either the study of various geometrical forms for their own sake or the application of such designs in artistic ornamentation.

[55] *Archiv für Geschichte der Mathematik, der Naturwissenschaften, und der Technik*, 12: 107.

[56] T. L. Heath, "History of Greek Mathematics," Oxford, 1921, vol. 2, p. 306, 344.

[57] R. H. M. Bosanquet and A. H. Sayce, "The Babylonian Astronomy," Royal Astronomical Society, *Monthly Notices*, 40: 108–109, 1880.

[58] First published, in part, by E. Hincks, in *Literary Gazette*, 38: 707, 1854, who surmised that the numbers referred to the portions of the moon visible on each of the first fifteen days of the month. This view was repeated by Hincks in Royal Irish Academy, *Polite Literature, Transactions*, 22: 407, 1855, and repeated by Cantor, Tropfke and Karpinski (see my Bibliography under Hincks, 1854 suppl.). They seem to have overlooked the correct interpretation.

Museum containing a record of the moon's longitude during thirty days; these numbers during the first fifteen days of its advance are: 5, 10, 20, 40, 80, 96, 112, 128, 144, 160, 176, 192, 208, 224, 240; then follow retrograde numbers 224, 208, 192, etc., the moon's daily motion being, for the most part, 16 out of 480 divisions of a circle, as it should be roughly. In a tablet from Sennacherib's palace (about 700 B. C.), now in the British Museum, a circle is divided into 480 equal parts.[59]

On the other hand, in discussing geometry of the Babylonians, Cantor states:[60] "for a certainty we have the division of a circle into 6 parts, then into 360 degrees." Heath's discussion of the question[61] involves no such positive statement, but he does note that it was Hipparchus, about 50 B. C., who first divided the circle in general into 360 parts or degrees, and that the introduction of this division coincides with his invention of trigonometry. In an article published by Thureau-Dangin last year[62] it was argued that the division of the circle into 360 parts by the Babylonians was "natural," but that further sexagesimal division was unnatural; also that the Babylonians made use of the division of the circle as learned from the Sumerians. It has appeared to me that the evidence favors the view of Bosanquet and Sayce that the division of the circle into 360 parts did *not* originate with the Babylonians.[63]

And finally, in connection with Babylonian geometry, there does not seem to be any problem where an expression for volume is clearly stated. It is true that Hilprecht discussed such an example but he was in doubt as to whether the object was a rectangular parallelopiped or not.

Egyptian Geometry

Let us first consider the problems of a geometrical nature, found chiefly in the Rhind and Golenishchev papyri. In the Rhind papyrus there are nineteen problems of this kind, namely: nos. 41–46, 48–60. The first six problems deal with volumes and the next eight with areas. In the first three are found volumes of circular cylindrical granaries of different diameters and heights. In each the process consists in multiplying the height by the area of the base which is found by the uniform rule of squaring eight ninths of the diameter of the base. This leads us to the value $256/81 = 3.1605 \ldots$ for π, a very remarkable approximation, used also in the Golenishchev papyrus and therefore practically contemporary with the Babylonian use of $\pi = 3$, about 2000 B. C. This same method of discussing the area of a circle is found in problem no. 48, where the areas of a circle and its circumscribed square are compared, and in no. 50, where the area of a round field of given diameter is asked for.

Among various writers who have conjectured how the Egyptian arrived at such a rule for the area of a circle are Demme, Simon and Vacca. In essence Simon's conjecture, which seems the most plausible, amounts to the following:[64] Suppose that two vessels of the same height, one with a circular base and the other with a square base equal to the circumscribed square of the circle, are filled with water. Then by weighing the water in each container it would be found that the quantities are as 64 to 81. Hence the result of problem no. 48 with reference to the relative areas of a circle and its circumscribed square would be found, and the rule for finding the area of a circle derived.

In problems 44 to 46 are discussed volumes and dimensions of parallelopipedal granaries. In other problems the area of a rectangular field of given dimensions is found, sections of a triangle similar to those considered by the Babylonians are discussed and two problems of the following type are solved: What equal areas should be taken from 10 fields if the sum of these areas is to be 7 setat?

Problem 51 is to find the area of a triangle given its base and altitude and 52 to find the area of a trapezium with apparently equal slanting sides, the lengths of the parallel sides and the distance between them being given numbers. These two problems have been the topic of many pages of discussion during the past fifty-three years. Some of the questions involved may be briefly set forth. In no. 51 the figure is a fairly good approximation to an isosceles triangle; beside the base and one of the sides are written certain numbers, half the product of which is given as the area of a triangle. Did the author of the papyrus think that the area of an isosceles triangle was one half the length of the base times the length of a side? Or was this triangle intended to be regarded as right angled and not isosceles? And, similarly in problem 52, did the author think that the area of the trapezium is one half the sum of the lengths of the parallel sides times the length of a slant height? Or was one side of the trapezium intended to be perpendicular to the parallel sides as in the case of those studied by the Babylonians?

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[59] D. E. Smith, "History of Mathematics," vol. 2, Boston, 1925, p. 230.

[60] M. Cantor, "Vorlesungen über Geschichte der Mathematik" vol. 1, 3rd ed., Leipzig, 1907, p. 50.

[61] T. L. Heath, "History of Greek Mathematics," vol. 2, 1921, p. 214–216.

[62] *Revue d'Assyriologie et d'Archéologie Orientale*, 25: 187–88, 1928.

[63] The weighty authority of B. Meissner ("Babylonien und Assyrien," vol. 2, Heidelberg, 1925, p. 385) favors the 360 division of the circle by the Babylonians; but the statement is made in such a way as to suggest that Meissner did not consider the question as carefully as he might have done.

[64] M. Simon, *Archiv d. Mathematik und Physik*, s.3, 9: 102, 1905.

In the great dedicatory inscription, of about 100 B. C., in the Temple at Edfu, as described by Lepsius, there are references to a large number of four-sided fields. For each of these the lengths of the sides (which we may call, in order as we go around, a, b, c, d) and their areas are given; these areas may be determined by the formula $(1/2)(a+c) \times (1/2)(b+d)$. If $a=c$, and b and d are parallel, we see that the Egyptians of 100 B. C. *did* use the formula that the area of a trapezium is equal to one half the sum of the parallel sides times the slant height, when these are equal. Moreover, if $a=c$, $d=0$, we get $\frac{1}{2}ab$ as the area of an isosceles triangle which is illustrated on the Edfu inscription by two examples $a=c=17$, $b=5$, area 85/8; $a=c=3$, $b=2$, area 3. These rules for calculating the areas of four-sided and three-sided fields are precisely those used by Egyptian natives to-day.[65]

It is, therefore, all the more interesting that in the period which we are considering the correct formulas were used for the areas of a triangle and a trapezium. The final proof of this, even when the figures are not isosceles, is given in papers published by Gunn and Peet in 1926 and last month.[66] The proof is based upon the analysis of the meaning of certain Egyptian words and of problem 4 of the Golenishchev, which is identical with no. 51 of the Rhind papyrus.

Five of the six remaining geometrical problems in the Rhind papyrus deal with the relation of the lengths of two sides of a right triangle which corresponds to the cotangent of the angle which a face of a regular pyramid makes with its base. This is called the *seked* of the pyramid. The seked 18/25 in problem 56 has been associated with the slope of the lower half of the southern stone pyramid of Dahshur, and the seked 3/4 in problems 57–59 with the slope of the second pyramid of Gizeh. The absurdities of such associations, even as made by Heath, I have recently shown elsewhere.[67]

Of six geometrical problems in the Golenishchev papyrus we have already noted the identity of no. 4 with a problem of the Rhind papyrus. In no. 6 we are given a rectangular enclosure of 12 units area and the ratio of the sides as 1 : 3/4 [1/2 1/4]; the lengths of the sides are found. The problem seems to be practically identical with one in the contemporary Kahun papyri in London. The solution of this problem may be regarded as equivalent to solving the simultaneous equation $xy=12$, $x:y=3/4$ [$-$1/2 1/4]. For the steps of the solutions in both papyri are as follows:

$$1:3/4=1\ 1/3;\ 1\ 1/3\cdot 12=16;$$
$$(16)^{\frac{1}{2}}=4\ [=x];\ 4\cdot 3/4=3\ [=y].$$

Two other geometrical problems in Berlin papyri fragments of about 1850 B. C. may be said to lead to simultaneous quadratic equations which are solved by the method of false position. The first of these is as follows:

> Distribute 100 square ells between two squares whose *sides are in the ratio* 1 *to* 3/4; the corresponding equations[68] are $x^2+y^2=100$, $x:y=1:3/4$. The solution is as *follows*: Try $x=1$, $y=3/4$, then $x^2+y^2=25/16$ [$=1\ 1/2\ 1/16$]. But $(25/16)^{\frac{1}{2}}=5/4$ [$=1\ 1/4$] and $(100)^{\frac{1}{2}}=10$. $10:5/4=8$, whence[69] $x=1\cdot 8=8$, $y=6$.

But while there is equivalence between the solutions of these ancient Egyptian problems and the solution of our algebraic simultaneous equations, so far as we know the Egyptian had none of our modern algebraic conceptions in this connection; he used methods which are wholly arithmetic, the idea of ratio and proportion being an important element. Cantor[70] and Tropfke[71] seem to be somewhat misleading in this regard.

The correct interpretation for no. 7 of the Golenishchev papyrus was given only last month by Gunn and Peet. It is: "A triangle of given area is such that its altitude is 2½ times its base; find both." The authors make clear that no. 17 is a similar problem for a scalene triangle.

But problems 14 and 10 of the Golenishchev papyrus contain the most extraordinary results in ancient geometry. In the first of these the conclusion is unavoidable that the Egyptian of about 1850 B. C. was familiar with our formula for the volume of a frustum of a square pyramid $V = \frac{h}{3}(a_1^2 + a_1 a_2 + a_2^2)$, where a_1 and a_2 are the sides of the square bases of the frustum, and h its height. Previous to 1917 it was not known that any particular case of the familiar general formula for the volume of the frustum of a pyramid given by Leonardo of Pisa in 1220 had been previously used. To learn then[72] that such a formula was known 3,000 years earlier was sufficient almost to revolutionize our ideas concerning the capability of the Egyptian as a geometer. Of course Heron of Alexandria, Brahmagupta and Mahāvīrācārya gave other forms for the volume of the frustum of a square pyramid. The exact text in this connection may be given:[73]

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[65] B. Gunn, *Journal of Egyptian Archaeology*, 12: 133, 1926.

[66] B. Gunn, *Journal of Egyptian Archaeology*, 12: 132–133, April, 1926. B. Gunn and T. E. Peet, *Journal of Egyptian Archaeology*, 15: 173–176, November, 1929.

[67] In my Bibliography.

[68] For the second problem, the equations are: $x^2+y^2=400$ and $x:y=2:1\frac{1}{2}$.

[69] We may note the relation in this problem of $1^2+(3/4)^2=(5/4)^2$, which has $3^2+4^2=5^2$ as a basis. Contrary to what is popularly believed, there is nothing to prove that the Egyptian knew the theorem regarding the squares on the sides of right triangles even in special cases.

[70] M. Cantor, "Vorlesungen über Geschichte der Mathematik," vol. 1, third ed., 1907, p. 95–96. It is true that Cantor treats these problems under the head of geometry and after his discussion states (p. 96): "Wir möchten bitten diese ganze Untersuchung, welche ihrem algebraischen Inhalte nach schon in das vorige Kapitel [arithmetic and algebra] gehören könnte, nicht als hier an unrichtiger Platze stehend bemängeln zu wollen. Sind doch die behandelten quadratischen Gleichungen aus geometrischen Aufgaben entsprungen."

[71] Tropfke, "Geschichte der Elementar-Mathematik," second ed., vol. 3, 1922, p. 56–57; these pages are in Tropfke's history of equations of the second degree.

> Example of calculating a truncated pyramid. If you are told: a truncated pyramid of 6 for the vertical height by 4 on the base by 2 on the top:
>
> You are to square this 4; result 16. You are to double 4; result 8. You are to square this 2; result 4. You are to add the 16 and the 8 and the 4; result 28. You are to take 1/3 of 6; result 2. You are to take 28 twice; result 56. See, it is of 56.
>
> You will find (it) right.

In a joint article, published last month by Gunn, Peet and Engelbach, detailed consideration was given to the question of how the Egyptian arrived at such a formula,[74] but to me their conclusions are not very convincing, even though we assume the great stage of their mathematical development which led them to the result of problem 10 which seems to be even more remarkable than the one just discussed.

In this problem taking the value of π used in the Rhind papyrus, the area of a hemisphere is found correctly, a result till recently supposed unknown before the time of Archimedes 1,600 years later. If d be the diameter of a hemisphere, each step of the work is equivalent to substitution in the formula:

$$S = [(2d - 2d/9) - (1/9)(2d - 2d/9)] \cdot d$$

which may be simplified to give $S = (1/2)(256/81)d^2$.

In concluding the survey of Egyptian geometry, reference may be made to a theory of F. G. Röber[75] who, from the study of ancient temple architecture and of the Temple of Edfu in particular, seemed to have divined that the layout was intimately connected with the construction of a regular heptagon. Over the ruler and compasses construction for this heptagon indicated by Egyptian architecture Sir William Rowan Hamilton grew highly enthusiastic; he showed[76] that the cosine of the angle subtended by a side of the heptagon thus constructed agreed to within two units in the seventh place of decimals with the value for the cosine of the seventh part of four right angles.

CONCLUDING COMMENT

Time will not allow me further to elaborate my topic. We have obtained some glimpses of the extraordinary mathematical achievements of the Egyptians during the golden period of their activity between 1600 and 1900 B. C. So far as we know at present practically no advance was made by them at a later date. We have met with some results, and many others could be adduced, which seem conclusively to show that the Egyptian studied mathematics for its own sake, and not alone for its practical applications. Breasted was led to make a similar deduction in connection with medical science after studying the remarkable Edwin Smith medical papyrus, soon to be published, which is also a document of the golden period of mathematical activity. What does the future have in store for the extension of our knowledge of Egyptian mathematics? The Golenishchev papyrus is to be published completely in the near future, but there are no other known unpublished Egyptian mathematical documents of this ancient period.[77]

We have seen that even our present knowledge of Babylonian mathematics indicates notable achievements, and suggests that they too must have studied mathematics for its own sake. But since there is a great deal of important Babylonian mathematical material in London, Berlin and elsewhere, its published interpretations hold extraordinary promise for the future enrichment of our knowledge of mathematics in these early days.

Until recently we have connected the Babylonians more with astronomical than with mathematical achievement, for they were famed for their knowledge of the heavens, and the pseudoscience of astrology originated with them. They were acquainted with the five planets Mercury, Venus, Mars, Jupiter and Saturn, distinguished the signs of the zodiac and made long lists of the fixed stars. The chief duty of the astronomer was to observe the moon for the purpose of keeping the calendar.[78] Their predictions of eclipses were made by a rule based upon the empirical discovery that there was a period of a little over eighteen years within which eclipses repeat themselves.[79]

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[72] B. A. Turaev, *Ancient Egypt*, 1917, p. 100–102.

[73] Gunn and Peet, *Journal of Egyptian Archaeology*, 15: p. 176.

[74] *Journal of Egyptian Archaeology*, 15: 179–184.

[75] F. Röber, "Beiträge zur Erforschung der geometrischen Grundformen in den alten Tempeln Aegyptens und deren Beziehung zur alten Naturerkenntniss," Dresden, 1854, p. 15–16.

F. Röber, "Elementar-Beiträge zur Bestimmung des Naturgesetzes der Gestaltung und des Widerstandes, und Anwendung dieser Beiträge auf Natur und alte Kunstgestaltung," Leipzig, 1861, p. 20–22.

[76] *Philosophical Magazine*, s. 4, 27: 124–132, 1864; R. P. Graves, "Life of Sir William Rowan Hamilton," vol. 3, Dublin, 1889, p. 141–148, 581–587. For other details in this connection see my Bibliography under 1854, and my notes in *American Mathematical Monthly*, 28: 477–479, 1921.

[77] I have referred in my Bibliography to a large unpublished geometrical Greek papyrus in Vienna found in the Fayûm and dating from about 350 B. C.

That Greek astronomy was based on the astronomy of the Babylonians is well known. We have noted that certain mathematical results regarded as original with the Greeks must, from now on, be attributed to the Babylonians and to the Egyptians. But whatever new facts are found concerning mathematics before the Greeks, the glory of their achievements in creating a vast body of deductive geometrical reasoning is not likely ever to be dimmed.

OBITUARY

EDWARD DRAKE ROE, JR.

DR. EDWARD DRAKE ROE, JR., for twenty-nine years professor of mathematics at Syracuse University, died suddenly at his home in Syracuse on Wednesday, December 11.

Dr. Roe had a long and distinguished career as student, educator, mathematician and astronomer. He received his bachelor's degree from Syracuse University in 1880. He then went to Harvard University where he first studied medicine and then returned to his studies in mathematics. He received a bachelor's degree from Harvard in 1885 and a master's degree in 1886. After teaching a few years, he went to the University of Erlangen, Bavaria, where he won his doctorate in 1898. He returned to America and was made associate professor of mathematics at Syracuse University.

In 1901 he was awarded the John Raymond French chair of mathematics and some years later was appointed director of the Holden Observatory of Syracuse University.

Dr. Roe built his own private observatory in connection with his own house. It was equipped with an Alvan Clark equatorial telescope and is considered one of the best-equipped private observatories in the country.

He was the author of nearly seventy scientific articles on mathematics, astronomy and philosophy. He was the author of a text-book in trigonometry and one in algebra.

He was the founder and director general of the honorary mathematical fraternity, Pi Mu Epsilon, and was a member of the Phi Beta Kappa, Sigma Xi, Pi Kappa Phi and Delta Kappa Epsilon. He was a fellow of the American Association for the Advancement of Science, a member of the American Mathematical Society, the founder and president of the Syracuse Astronomical Society, a member of the Deutsche Mathematiker Vereinigung, Circolo Matematico di Palermo and Société Astronomique de France.

Dr. Roe stood for high scholarship, thorough scientific study and research. He impressed all who knew him as a scholar with a deep thirst for knowledge. He worked with untiring patience in mathematics and its allied science astronomy in the university and in the community.

Throughout his years of service as a teacher Dr. Roe always stood for the highest ideals of intellectual honesty and scientific achievement. He was a devoted teacher, a deep thinker, a philosopher and an earnest Christian. In his death Syracuse University has suffered a distinct loss.

ALAN D. CAMPBELL

MEMORIALS

THE American Electrochemical Society has announced its intention of establishing the Joseph W. Richards Memorial Fund, the interest of which is to be used as an honorarium to foreign electro- and physical chemists who are to be invited by the society from time to time. The guests will present lectures at annual spring conventions of the American Electrochemical Society, and possibly at universities and other institutes of learning. Professor Richards was secretary of the American Electrochemical Society for almost twenty years and was very largely responsible for the founding of the society. He was ever a very strong advocate in fostering better relations between our own scientists and scientists abroad, inviting and entertaining many notables at his own expense. The many friends of Professor Richards, therefore, feel that this memorial to him is a most fitting one. All those interested are invited to send their contributions to the secretary of the American Electrochemical Society, Columbia University, New York City, making all checks payable to the Joseph W. Richards Memorial Fund. It is the desire of the Board of Directors of the society that the list of contributors include as many as possible of Professor Richards' friends and acquaintances, and subscriptions in any amount are invited.

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[78] British Museum, "Guide to the Babylonian and Assyrian Antiquities," London, 1922, p. 25.

[79] For a summary of Egyptian astronomy see T. E. Peet, "The Sciences" in "The Cambridge Ancient History," Cambridge, vol. 2, 1924, pp. 218, 656.

Industrial and Engineering Chemistry reports that the debt of modern science and industry to Karl Wilhelm Scheele, distinguished Swedish chemist and discoverer of glycerol, was recognized at the annual meeting in Chicago on December 11 of the Association of American Soap and Glycerine Producers, representing the leading soap manufacturers of the country. The association sent to Crown Prince Gustaf Adolf, honorary member of the Royal Academy of Sciences of Sweden, a message felicitating him on the part played by his country in the development of glycerol products. December 19 marked the one hundred and eighty-seventh anniversary of Scheele's birth, and 1930 marks the sesquicentennial of his discovery.

THE London correspondent of the *Journal* of the American Medical Association writes: "Sir Patrick Manson, who died in 1922, established the principle of the insect transmission of disease, and at the international medical congress held in London in 1913 he was acclaimed the father of tropical medicine. In 1907, with the help of Cantlie and others, he founded the Society of Tropical Medicine and Hygiene, of which he was the first president. Among its fellows, now numbering 1,500 of many nationalities, are those most distinguished in tropical medicine. Its work is hindered by lack of suitable premises. The society has decided to found a home and name it after Manson, to whom at present there is no memorial. The fellows and some friends have subscribed $30,000 toward the purpose and are appealing for $100,000 to which they believe that many outside the small professional circle of tropical medicine who know of Manson's labors as a leader of medicine and one of the world's benefactors will desire to subscribe. His great work began in Amoy in 1877 with his demonstration that the filaria of elephantiasis is transmitted by certain mosquitoes. This was no chance discovery but the result of labor done in isolation. So his conviction that malaria was transmitted by mosquitoes was no inspired guess but was founded on his long critical watching of the malarial parasite in human blood and led Ross to the final victory. Donations will be gratefully received by the Royal Society of Tropical Medicine, 11 Chandos Street, Cavendish Square, London, W 1."

RECENT DEATHS

DR. FLETCHER BASCOM DRESSLAR, professor of school hygiene in the Peabody College for Teachers, died on January 19, at the age of seventy-one years. Dr. Dresslar had been president of the Tennessee Academy of Sciences.

PHILIP NORTH MOORE, consulting geologist and mining engineer, president of the American Institute of Mining Engineers in 1917, died on January 20 at the age of eighty years.

STEPHEN TYNG MATHER, who was director of national parks in the Department of the Interior, died on January 22 at the age of sixty-two years.

DR. CAROLINE A. BLACK, who had been twelve years on the faculty of Connecticut College, latterly as associate professor of botany and chairman of that department, died on January 19 at Cincinnati, Ohio, of spinal meningitis. She was taken ill when returning from the American Association for the Advancement of Science meeting at Des Moines.

HUGH LONGBOURNE CALLENDAR, professor of physics at the Imperial College of Science, London, died on January 23, at the age of sixty-six years. He was distinguished for his work in connection with the measurement of the heat radiation of steam at high pressure. Dr. Callendar was professor of physics at McGill University from 1893 to 1898.

MAJOR PERCY ALEXANDER MACMAHON, F.R.S., the distinguished English mathematician, died on Christmas Day at his residence at Bognor, at the age of seventy-five years.

DR. DE FERRANTI, electrical engineer, inventor and manufacturer, died on January 14 at the age of sixty-five years. Dr. Ferranti was a past president of the British Society of Electrical Engineers. He was awarded the Faraday Medal of the Institution of Electrical Engineers in 1924, and was elected a fellow of the Royal Society in 1927. The University of Manchester gave him the honorary degree of D.Sc. in 1911.

SCIENTIFIC EVENTS

COMMISSIONS OF THE INTERNATIONAL GEOLOGICAL CONGRESS

IN its report of the congress *Nature* states that during the session a series of meetings was held in connection with the various international commissions, the work of which is an important feature in the life of the congress. In the end, several commissions had to be reconstituted, one new commission and one subcommission were established, while of the previous bodies, one (iron ores) was dissolved, so that the Congress now has the following commissions: Prix Spendiaroff (awarded to Dr. L. T. Nel, geologist on the Geological Survey of the Union of South Africa), Palæontologia Universalis, Lexicon de Stratigraphie, Glaciers, L'Homme Fossile, Croûte Terrestre, Géophysique et Géothermique, Carte de l'Europe, Carte de la Terre, Distribution of the Karroo (Gondwana) System; to these was added the subcommission of African Surveys.

It is said that since the last meeting of the congress, in Spain during 1926, much useful work has been accomplished by the two map commissions, under the chairmanship of Dr. P. Krusch, president of the Geological Survey of Prussia. The one for the map of Europe on the scale of 1:1,500,000 was founded at Bologna in 1881, and shortly after the Toronto congress in 1913 completed its task by publishing the last sheet, and the preparation of a new edition was afterwards decided upon. The indispensable preliminary work of agreeing upon the best color scheme was completed at a meeting of the commission held in Berlin last February, and during the South African meeting Dr. W. Schriel (general secretary of the commission) exhibited two advance sheets of the new edition, in their original form; the great beauty of the color scheme and the excellence of the draftsmanship were much admired by many members. One section of the new edition is ready for the press and further sections are expected to appear at the rate of two in each year.

The publication of the International Map of the World on the scale of 1:5,000,000 was decided upon at the Stockholm congress in 1910, and the color scheme drafted at the Berlin meeting referred to, two sections embracing the Union of South Africa being afterwards prepared; they were presented at the Pretoria meeting. For the next congress it was agreed to prepare a few North American sections.

The final editing is to be done at Berlin (as was formerly the case) in order to secure uniformity of issue, for which purpose a special bureau has been established at Berlin. Dr. P. Krusch (chairman of both map commissions) was able to announce the fortunate circumstance that the means for the printing of both maps have been made available by Prussia, so that in due course the sheets will be obtainable through the Geological Survey of that country.

THE GREAT SMOKY MOUNTAIN NATIONAL PARK

THE states of North Carolina and Tennessee have notified the secretary of the interior that they have acquired and are ready to turn over to him a minimum of 150,000 acres of land in what is ultimately to constitute the Great Smoky Mountain National Park on their border line. Representatives of these two states, including their governors and attorneys general, and members of their park commissions, will go to Washington on February 6 and formally tender to Secretary Wilbur the title to this initial area, duly passed and warranted by the states.

This action on the part of these two states will mark the first delivery of Great Smoky Mountain park land to the government and the first concrete step toward the actual consummation of the project. It will constitute the first physical transfer of land to the government and mark the passing of the Great Smoky Mountain project from a theoretical conception to an actual accomplishment. It means that the government actually will have received a tract of land more than twice as big as the District of Columbia as a nucleus around which to develop a model wilderness area into a national park of the east.

The law which provided for the creation of the Great Smoky Mountain National Park and the Shenandoah National Park made their acceptance by the government conditional upon the presentation of complete title to the land. The states must acquire the land and deliver it to the federal government. It would then be placed under the National Park Service for administration and development.

Investigations had shown there were practically 704,000 acres of land in the Great Smoky Mountain district, an area as big as Rhode Island, that was suitable for park purposes. The law provided that when a minimum of 150,000 acres of this land was presented to the government, it should be accepted and that the government should thereafter administer and protect it. This, however, was to be but a nucleus of the contemplated park.

The law further provided that the states must acquire and present to the federal government, in addition to this 150,000 acres, the majority of the remaining available park land in this section. That available remaining land amounts to 554,000 acres. Half of it would be 277,000 acres which must yet be acquired by the states and presented to the federal government before it will consider the park area adequate and proceed with its actual development. It will accept the lesser area for administration and protection, but not for development. When it has received a minimum of 427,000 acres from the states of North Carolina and Tennessee, an area as big as seven Districts of Columbia, the National Park Service will proceed to develop it on a basis comparable to that used at Yellowstone, Yosemite and other of the great national parks in the west.

The acquisition of the minimum acreage required before development work may begin seems assured. The states of North Carolina and Tennessee between them have raised, in round numbers, nearly $5,000,000 to be used in the purchase of this land. The Laura Spelman Rockefeller Memorial has contributed an additional amount, but not exceeding $5,000,000, which is also available for the purchase of land. These amounts are considered adequate for the acquisition of the minimum area required by the law. That acquisition but awaits the details of purchase, the local examination of titles and, in some cases, condemnation procedure where it is necessary. It would appear, therefore, that the establishment of a Great Smoky Mountain National Park, with the delivery of land titles on February 6, will pass into the final stages of actual accomplishment.

INTERNATIONAL EXPEDITION TO THE BAHAMAS UNDER THE AUSPICES OF PRINCETON UNIVERSITY

Plans have been completed for an international expedition to the Bahamas under the auspices of Princeton University, from February 1 to April 15. The expedition is under the direction of Professor R. M. Field, of Princeton University, and is being supported by Mr. Hugh Matheson, of Miami, who is lending his yacht the *Marmion,* and with the cooperation of the following institutions:

The Percy Sladen Trust of London
The Rouse Ball Fund of Trinity College, Cambridge
Die Notgemeinschaft der Deutschen Wissenschaft
The U. S. Coast and Geodetic Survey
The American Museum of Natural History
The Buffalo Society of Natural Sciences
State of New Jersey Agricultural Experiment Station
The International Summer School of Geology and Natural Resources

The subjects of research and the personnel are as follows:

1. *Navigation:* Mr. Hugh Matheson, Miami.
2. *Gravity Determinations:* Under the direction of Dr. William Bowie, of the U. S. Coast and Geodetic Survey. Ensign Joseph P. Lushene in charge of field work.
3. *Marine Biology:* Professor Ulric Dahlgren, department of biology, Princeton University. Dr. Roy W. Miner, curator of invertebrate zoology, American Museum of Natural History.
4. *Bacteriology:* Dr. S. A. Waksman, State of New Jersey Agricultural Experiment Station, Rutgers University. Dr. Werner Bavendamm, Technische Hochschule, Dresden.
5. *Geology: Percy Sladen Trust Expedition to Andros Island.* Mr. Maurice Black, fellow of Trinity College, Cambridge, and Commonwealth Fund fellow, department of geology, Princeton University.
6. *Marine Sedimentation:* Professor R. M. Field, department of geology, Princeton University, and research associate, Buffalo Society of Natural Sciences. Dr. Ernest Dixon, British Geological Survey.
7. *Oceanography:* Dr. Charles Fish, Buffalo Society of Natural Sciences.

The purpose of the expedition is to continue the study of the physical, chemical and biological conditions governing the character of the sediments in the region, as well as the effect which these sediments have upon the life and habits of the marine organisms.

The expedition is expected to yield new and interesting data concerning oceanographic and biologic problems, and it is hoped that the results obtained will supply information which will be of aid in interpreting certain geological problems, such as the origin of limestones and dolomites and the habitats of marine organisms in the ancient tropical seas. One of the fundamental geological problems in this region is the question of the origin of the islands, as well as the relation of their stability to the character of the sediments which mantle their surfaces.

BRITISH HONORS

Nature reports that the New Year Honors list of Great Britain contains the names of the following men of science and others associated with scientific work: *Baronets:* Sir Gregory Foster, who has retired from the post of provost of University College, London, and was recently vice-chancellor of the university; Sir Eustace Tennyson-D'Eyncourt, at one time director of naval construction, admiralty. *K.C.M.G.:* Lieutenant-Colonel Andrew Balfour, member of the Colonial Advisory Medical and Sanitary Committee and director of the London School of Hygiene and Tropical Medicine. *Knights:* Professor T. P. Nunn, principal of the London Day Training College and professor of education in the University of London; Mr. Archibald Page, chief engineer and manager of the Central Electricity Board and a past president of the Institute of Electrical Engineers; Mr. Alexander Rodger, inspector-general of forests, Government of India; Professor T. Zammit, curator of the museum, Malta. *C.I.E.:* Mr. B. C. Burt, Imperial Council of Agricultural Research, India; Mr. H. L. Newman, chief conservator of forests, Bombay; Mr. S. Walker, chief engineer and secretary for irrigation, North-West Frontier Province, India. *C.B.E.:* Professor J. S. S. Brame, professor of chemistry and metallurgy, Royal Naval College, Greenwich; Mr. G. E. S. Cubitt, lately conservator of forests, Straits Settlements and Federated Malay States; Captain A. T. A. Dobson, assistant secretary, Ministry of Agriculture and Fisheries. *O.B.E.:* Mr. Joseph Jones, formerly curator of the Botanic Gardens, Dominica; Mr. W. A. S. Lamborn, medical entomologist, Nyasaland Protectorate; Captain R. N. Liptrot, principal technical officer, Air Ministry; Mr. W. R. Mustoe, superintendent of horticultural operations; Delhi; Dr. E. S. Russell, director of fishery investigations, Ministry of Agriculture and Fisheries. *M.B.E.:* Mr. John Aikman, assistant, Royal Botanic Gardens, Kew; Mr. E. A. Bearder, technical adviser, Dyestuffs Advisory Licensing Committee; Mr. A. A. Gomme, librarian, Patent Office, Board of Trade.

SCIENTIFIC NOTES AND NEWS

PROFESSOR GILBERT N. LEWIS, dean of the college of chemistry in the University of California, has been elected an honorary member of the Swedish Academy of Sciences.

DR. J. S. PLASKETT, director of the Dominion Astrophysical Observatory at Victoria, B. C., has been awarded the gold medal of the Royal Astronomical Society, London, "for his valuable observations of stellar radial velocities, and the important conclusions derived from them."

PROFESSOR WILLIAM H. BRAGG, Fullerian professor of chemistry at the Royal Institution, London, and Dr. Godfrey Harold Hardy, professor of geometry at the University of Oxford, have been elected members of the Prussian Academy of Sciences.

THE council of the British Institution of Electrical Engineers has made the ninth award of the Faraday Medal to Sir Ernest Rutherford, Cavendish professor of experimental physics and director of the Cavendish Laboratory at the University of Cambridge. The medal is awarded for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science, irrespective of the recipient's nationality.

M. CHARLES NICOLLE, head of the Pasteur Institute at Tunis, has been elected a member of the French Academy of Sciences. Dr. Nicolle was awarded a Nobel Prize in 1928. He discovered the bacillus of typhus and that of the "Mediterranean fever."

THE University of Edinburgh has conferred the doctorate of science on Professor R. S. Adamson for his studies in plant ecology and plant anatomy.

DR. WALTER B. CANNON, George Higginson professor of physiology at the Harvard Medical School, who is Harvard exchange professor at the Sorbonne, Paris, has been appointed Linacre lecturer for 1930 at the University of Cambridge.

PROFESSOR OTIS EVERETT RANDALL, professor of applied mathematics at Brown University, where he has taught since 1885, will retire in June, having reached the age limit of seventy years.

THE staff and students, including many former students, of the Osborn Zoological Laboratory at Yale University, on January 13 celebrated the sixtieth birthday of Dr. Ross G. Harrison, Sterling professor of biology and director of the laboratory. During the afternoon a reception for Dr. Harrison was held in the building, at which a handsome watch, appropriately inscribed, was presented to him on behalf of the staff and students by Professor W. R. Coe, senior member of the departmental faculty. Dr. S. R. Detwiler, professor of anatomy at Columbia University, one of Professor Harrison's early students, presented to him the current volume of the *Journal of Experimental Zoology*, entirely composed of contributions by Dr. Harrison's students and prefaced by his portrait. Later an informal dinner was held at the Faculty Club. In addition to congratulatory telegrams and letters from many individual biologists at home and abroad, Dr. Harrison received felicitations from the Statione Zoologica at Naples, the Kaiser-Wilhelm Institut für Biologie at Berlin and the Medical Faculty of the University of Bonn where he received the degree of M.D. thirty years ago. The University of Freiburg conferred upon him the honorary doctorate of philosophy.

THE Swedish Geographical Society has presented its medal to General Umberto Nobile, Italian commander of the *Italia* Polar Expedition of two years ago. General Nobile lectured before the society on the expedition and paid a tribute to Finn Malmgren, who lost his life on the ice north of Spitzbergen.

THE Geological Society of London has this year made the following awards of medals and funds: The Wollaston Medal to Professor A. C. Seward, master of Downing College, and professor of botany in the University of Cambridge, for his researches in stratigraphy and palaeobotany; the Murchison Medal to Mr. A. L. Hall, of the Geological Survey of South Africa, for his researches on the stratigraphy and economic geology of South Africa; a Lyell Medal to Mr. F. Chapman, paleontologist to the federal government of Australia, for his work in paleontology (especially on the Foraminifera), and for his researches on the Tertiary rocks of Australia; a second Lyell Medal to Mr. H. B. Maufe, director of the Geological Survey of Southern Rhodesia, for his work on the geology and mineral resources of that colony; the Wollaston Donation Fund to Mr. E. G. Radley, of H. M. Geological Survey, for his work on the chemical analysis of rocks and minerals; the Murchison Geological Fund to Mr. John Smith, of Dalry, for his contributions to the geology and paleontology of Western Scotland; the Lyell Geological Fund to Miss

H. M. Muir-Wood, for her work on the paleontology of the Brachiopoda.

Dr. R. A. F. Penrose, Jr., of Philadelphia, formerly professor of geology in the University of Chicago, was elected president of the Geological Society of America at the recent annual meeting.

Dr. Alfred M. Tozzer, professor of anthropology and curator of Middle American archeology and ethnology at the Peabody Museum at Harvard University, has been elected president of the American Anthropological Association.

The Mineralogical Society of America held its tenth annual meeting at the Wardman Park Hotel, Washington, D. C., on December 26, 27 and 28, 1929, in conjunction with the Geological Society of America. The following officers were elected for 1930: *President,* Herbert E. Merwin, Geophysical Laboratory, Washington, D. C.; *vice-president,* John E. Wolf, Pasadena, California; *treasurer,* Albert B. Peck, University of Michigan; *secretary,* Frank R. Van Horn, Case School of Applied Science; *editor,* Walter F. Hunt, University of Michigan; *councilor,* 1930–33, Paul F. Kerr, Columbia University. Dr. Gregori Aminoff, director of the mineralogical department of the State Museum of Natural History, Stockholm, was elected a fellow.

Dr. Detlev W. Bronk has resigned his position as dean of men and professor of physiology and biophysics at Swarthmore College to become professor of biophysics and director of the Johnson Foundation for Medical Physics in the University of Pennsylvania.

Dr. Richard Bradfield, formerly associate professor of soils at the University of Missouri, has been appointed professor at the Ohio State University.

Professor J. H. Ashworth, of the department of zoology of the University of Edinburgh, known for his work on marine annelids, will have charge of the post-graduate seminar in zoology at the University of California from May 19 to June 28, 1930. He will arrive in New York early in April and before going to Berkeley will visit the large eastern universities and the government laboratories in Washington and during his stay will visit the principal biological laboratories in the United States.

The Mexican Department of Public Health has intrusted to Dr. Alfons Dampf, chief entomologist and head of the department of research in the Mexican Department of Agriculture, the study of the blood-sucking flies and other insects in the regions of the State of Guerrero where the "Mal del Pinto" exists. The etiology of this skin disease is absolutely unknown. As the chief centers of infestation are always near a watercourse, there is a slight probability that the transmitter may be a dipterous insect with an aquatic larva. Dr. Dampf's first trip to Guerrero was made in the month of December; the next will be made in March.

At the instance of the research coordination subcommittee of the British Committee of Civil Research, the forestry commissioners have constituted an Advisory Committee on Forestry Research. The members of the committee are as follows: Mr. R. L. Robinson (vice-chairman of the Forestry Commission), *chairman;* Dr. E. J. Butler (director, Imperial Bureau of Mycology); Dr. A. W. Hill (director, Royal Botanic Gardens); Dr. A. S. Joseph (director, Bureau of Soils); Dr. Guy Marshall (director, Imperial Bureau of Entomology); R. S. Pearson (director, Forest Products Research Laboratory); Professor R. S. Troup (director, Imperial Forestry Institute); Professor Wright-Smith (director, Royal Botanic Garden, Edinburgh); *secretary,* Mr. W. H. Guillebaud.

Dr. C. W. Edwards, professor of physics in Duke University, writer and lecturer on physics, on the occasion of the annual meeting of Sigma Pi Sigma, spoke at Davidson College, North Carolina, on "Properties of Matter at Very Low Temperatures."

Professor A. V. Hill will give a course of four public lectures at the University of London on oxygen and the recovery process in muscle and nerve beginning on January 20, and continuing on January 27 and February 3 and 10. A course of four public lectures on the chemistry of muscle in relation to problems of cellular physiology will be given at the university by Professor Otto Meyerhof, director of the Institute of Physiology of the Kaiser-Wilhelm Institut, Berlin, on March 6, 7, 10 and 12.

Dr. William Bosworth Castle in physiology and Dr. Frank Roberts Ober in orthopedic surgery have been promoted to assistant professorships in the Harvard Medical School.

Dr. Ch. Terzaghi, of the Massachusetts Institute of Technology, has been offered the professorship of hydraulics at the Technical Institute in Vienna.

Dr. R. J. Brocklehurst, lecturer in University College, has been appointed to the chair of physiology in the University of Bristol.

Terrestrial Magnetism reports that Dr. F. Lindholm, first Swedish state meteorologist, who was released by his government in 1926 that he might assume the directorship of the Physikalisch-Meteorologisches Observatorium Davos, founded by Dr. C.

Dorno, has given up that post in order to resume his former position. He is succeeded in the directorship of the Davos Observatory by Dr. W. Mörikofer.

DR. WILLIAM A. ARCHER, plant pathologist, recently of the U. S. Department of Agriculture, Office of Plant Disease Survey, has resigned to accept the position of professor of plant pathology in the School of Agriculture and Veterinary Science at Medellin, Department of Antioquia, Colombia. Previous to his departmental service Dr. Archer was engaged in teaching and research work in biology at New Mexico State Agricultural College, the University of Michigan and Oberlin College. He began his new work in South America on January 15. Mr. Charles H. Ballou, recently technical assistant in the U. S. Department of Agriculture Japanese Beetle Control Laboratory at Moorestown, New Jersey, has also gone to Medellin, to take the position of professor of entomology. Mr. Ballou is a graduate of Cornell University and has spent the past several years in entomological research in the tropics, particularly in Cuba. The appointments of Dr. Archer and Mr. Ballou were arranged through the Tropical Plant Research Foundation of Washington.

DR. LINSLY R. WILLIAMS, chief deputy of the late Dr. Hermann Biggs when the latter was New York State Health Commissioner under Governor Smith, has been offered the position of head of the State Health Department to succeed Dr. Matthias Nicoll, Jr., who recently retired to take up health work for Westchester county.

R. V. MCGREW, formerly of the University of Nebraska, Northwestern University and Harvard University, now a research chemist with the Rohm and Haas Company, has been transferred from their Philadelphia laboratory to the Pennsylvania State College.

ASSOCIATE PROFESSOR HERBERT W. RAND, of the department of zoology of Harvard University, will be on leave of absence during the second half of the current academic year.

THE afternoon lectures at the Royal Institution, London, were resumed on January 21, when Dr. F. W. Aston began a course of three lectures on Tuesday afternoons on "Isotopes"; on succeeding Tuesdays there will be four lectures by Sir William Bragg on "X-Ray Determination of the Structure of Cellulose and Similar Substances," and four by Dr. Charles Singer on "The Passage from Mediaeval to Modern Science." On Thursday afternoons, beginning on January 23, were two lectures by Dr. H. A. Harris on "The Growth of Children in Health and Disease," one on February 6 by Dr. R. L. Smith Rose, on "Radio Direction Finding by Transmission and Reception," and two by Mr. T. A. Joyce on "Architecture and the Industrial Arts of Pre-Spanish America." The Saturday afternoon lectures will include four by Sir Ernest Rutherford on "Atomic Nuclei and Their Structure." The first Friday evening discourse was given on January 24, when Sir William Bragg spoke on "Cellulose in the Light of the X-Rays." Succeeding discourses will probably be given by Lord Rayleigh, Dr. Leonard Hill, Professor A. F. Pollard, Professor G. I. Taylor, Mr. C. Tate Regan, Professor G. Elliot Smith, Mr. Seton Gordon, Sir Ernest Rutherford and others.

DR. LUDWIG PRANDTL, professor of physics, mechanics and thermodynamics, and director of the Kaiser Wilhelm Institute for Research in the Flow of Fluids at the University of Göttingen, will give two public lectures on the flow of gases and fluids at the Carnegie Institute of Technology. On the first night his subject will be "Flow of Gases at Velocities above Those of Sound," and on the second night he will speak on "Molecular Theory of the Elastic Hysteresis of Plastic Flow." The great aerodynamic laboratory which he directs is widely known. The wind-tunnel in this laboratory is being taken as a model throughout the world. The tunnel being constructed now at the Carnegie Institute of Technology is patterned after the Göttingen type. Dr. Prandtl comes to Pittsburgh from the University of Michigan where he has given a series of lectures. A dinner was given in his honor at the Faculty Club of the University of Pittsburgh.

THE Abraham Flexner Lectures for 1930–1931 will be delivered by Sir William Hardy, of the University of Cambridge. Sir William, who was knighted for contributions to science, has delivered the Croonian and Bakerian Lectures in England. He is a past secretary of the Royal Society, and now is conducting experiments on the cold storage and preservation of foods for the British Government. He is director of the Low Temperature Research Station of Biochemistry and Biophysics at Cambridge. The first series of the Flexner Lectures was delivered last year by Dr. Heinrich Pohl, director of the Anatomic Institute of Hamburg, Germany.

THE Second International Congress on Malaria will be held in Algiers, from May 19 to 21, 1930. Delegates of governments, of scientific institutions and societies and physicians who wish to attend the congress are requested to register their names as soon as possible with the Secrétariat-Général du deuxième Congrès internationale du Paludisme, Institut Pasteur, Algiers. French railways and steamship companies will accord favorable rates to those attending. The secretary wants to know the numbers to be arranged for on ships in the Mediterranean and lodged in Algiers.

THE first International Anatomical Congress to be held since the war will meet at Amsterdam next summer from August 4 to 9.

THE Annual Congress on Medical Education, Medical Licensure and Hospitals will be held at the Palmer House, Chicago, February 17, 18 and 19, under the auspices of the Council on Medical Education and Hospitals of the American Medical Association.

ON January 14 there was held a meeting in the hall of the Franklin Institute, Philadelphia, to which were invited the advanced students in physics from Haverford, Swarthmore, Bryn Mawr and Villa Nova Colleges, the University of Pennsylvania, the Moore School of Engineering, Delaware and Temple Universities and Drexel Institute. The meeting was addressed by Dr. Herbert E. Ives, of the Bell Laboratories, New York City, on "Physics and a Large Industrial Organization," and by Professor Karl T. Compton, of Princeton University, on "Physics and a Large University." It is proposed to hold further meetings at which other opportunities open to students of physics will be discussed.

THE third annual conference of workers with the *Phymatotrichum omnivorum* root-rot of cotton and other plants was held on January 15 at the Kyle Hotel, Temple, Texas. A. B. Conner, director of the Texas Agricultural Experiment Station, presided at the morning session, and Dr. A. G. McCall, chief of soils investigations of the U. S. Department of Agriculture, Bureau of Chemistry and Soils, at the afternoon session. On January 16, the scientists and others at the conference visited the Blackland Substation, near Temple, of the Texas Experiment Station system. Forty papers were presented, giving the results of work during the past year at the various state and federal stations where the disease is under investigation. These papers will be summarized in a forthcoming report in *Phytopathology.*

Museum News reports that the British Museums Association has organized a permanent staff and established headquarters at 39 Alfred Place, opposite South Kensington Station, London. Sydney Frank Markham, M.P., has been appointed by the executive committee as permanent secretary and Miss Vera Cummings as full-time assistant to Mr. Markham. At the unanimous request of the committee Sir Henry Miers has accepted reelection to the presidency for the year 1930–31. Mr. Markham plans to compile a directory of museums to include all institutions in the British Dominions. The establishment of a permanent organization is made possible by a grant of £1,500 from the Carnegie United Kingdom Trust. The next annual conference of the association will be held in Cardiff, from June 23 to 27.

THE Rockefeller Foundation at the meeting of its Board of Directors last month appropriated the sum of $155,000 a year for two years beginning with the summer of 1930 to continue the support of post-doctorate fellowships in physics, chemistry and mathematics with the understanding that approximately $125,000 of this sum will be expended for the support of American fellows in the United States and about $30,000 for the support of American fellows abroad. At the same time the Rockefeller Foundation appropriated the sum of $20,000 a year for two years beginning next summer for the support of American fellows in the biological sciences who wish to work abroad.

THROUGH the courtesy of the U. S. Government Bureau of Mines, the Canadian Department of Mines, Ottawa, has received the following motion picture films for free circulation throughout Canada: "The Story of Sulphur" (2 reels); "The Story of Rock Drilling" (2 reels); "The Story of Steel" (6 reels); "The Story of Gasoline" (3 reels); "Heat Treatment of Steel" (2 reels); "Through Oil Lands of Europe and Africa" (2 reels); "The Story of Dynamite" (2 reels), and "Carbon Monoxide: The Unseen Danger" (1 reel). All these films are on standard (35 mm) stock, and all are non-inflammable except "The Story of Rock Drilling." No charge is made for the rental of the films, but the borrower is expected to pay express charges.

A CORRESPONDENT writes: "The indefatigable Chilean naturalist, Dr. Carlos E. Porter, of Santiago, Chile, has announced the coming publication of a very large work entitled (translated) "Historical Review and Bibliography of Natural Science in Chile." He is compiling under this title a work to be issued in eighteen volumes. These will contain brief biographies of a large number of prominent men in the field of natural sciences, with their portraits, and over fifteen thousand bibliographic references relating to the anthropology, fauna, flora, geology, paleontology and mineralogy of Chile. They will contain also an abridged statement on all the biological work concerning applied zoology and botany as well as agriculture, medical science and veterinary science. After the publication of all the eighteen volumes, supplementary volumes will be issued at intervals of four years. The work of South American naturalists is not as well known in the United States as it should be, and there can be no doubt that this great work will be of much assistance to all naturalists.

APPLICATIONS for the Eastern fellowship in analytical chemistry provided by the J. T. Baker Chemical Company, which is of the value of $1,000, should be made before February 13. The fellowship is available for students in any institution conferring the doctor's degree in chemistry in the New England States, New York, Pennsylvania, New Jersey, Delaware and Maryland. The committee on award is as follows: N. H. Furman, Princeton University, chairman; Gregory P. Baxter, Harvard University; Philip E. Browning, Yale University, secretary; E. M. Chamot, Cornell University, and H. A. Fales, Columbia University. The Mid-Western Fellowship will be available for students in any institution conferring the doctor's degree in chemistry in Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio and Wisconsin. Applications may be sent by any member of the teaching staff who is qualified to supervise a doctor's dissertation. Further information may be secured from the committee: H. H. Willard, University of Michigan, Chairman; C. W. Foulk, Ohio State University; Stephen Popoff, Iowa State University; G. F. Smith, University of Illinois.

DISCUSSION

THE CENTRAL ASIATIC EXPEDITION

We have been sorry for controversy which arose from the case of the Central Asiatic Expedition led by Dr. Roy Chapman Andrews, and the interpretation given to this by Dr. Henry Fairfield Osborn as he wrote it in the September 27 issue of SCIENCE. We shall be much obliged if you can publish this letter and the accompanying statement for the information of American scientific public.

The meaning and the reason of the proposed agreement (text already reported by Dr. Andrews) put forward by the Chinese committee are already explained in our statement of April 19, and need not be repeated. Certain restriction of extensive collection by foreign expeditions and of the export of large amounts of scientific material is not without precedent in scientific world, and does not mean antiforeignism. The opinion of the Chinese committee is that such large expeditions should be allowed only on the condition of a close cooperation with Chinese scientific bodies and the retention of complete representative collection in China. Such has been the principle in the committee's action dealing with all other foreign expeditions, while Dr. Andrews has tried to avoid Chinese participation before the autumn of 1928 and always to obtain unconditional authorization.

The committee is always ready to consider any practical proposal toward the solution of the problem and regrets to see the exaggerated meaning purposely given to the incident in order to disturb American opinion. It is hoped that Dr. Osborn, well known for his broad mind and sane judgment, and other American scientists will find no difficulty in understanding the true Chinese attitude.

The statement follows:

Public opinion in China was aroused against the export of a large amount of important scientific material by the Central Asiatic Expedition from Chinese territory without any Chinese control or participation in preceding years. The case is the more surprising that such extensive excavations were done under the cover of a passport for hunting only. Some negotiations took place and an agreement was reached in October, 1928, between this committee and Dr. Andrews, the leader of the Central Asiatic Expedition, providing certain conditions for the return of duplicate specimens and casts and the possibility of organizing future expeditions under new conditions of cooperation to be agreed upon.

At the beginning of February, 1929, Dr. Granger on behalf of the Central Expedition in a letter approached this committee for permission to launch a new paleontological expedition to Inner Mongolia and proposed on his own initiative (1) to take two Chinese scientists on the expedition and (2) to return after study a complete set of duplicate specimens or casts of vertebrate fossils.

These proposals were carefully considered by this committee in a full sitting of all its members present in Peking together with the members of the Peiping local committee. It was then decided that a draft agreement be made which, while giving full consideration to the scientific interest of the expedition, tries to provide for necessary safeguards of Chinese interest and cooperation in this important scientific enterprise.

The full text of the proposed agreement is herewith appended. From the Chinese point of view a complete set of the fossils collected including unique specimens should be kept in or returned to China after study. But in view of the large expenses borne by the expedition and the scientific interest of the American Museum of Natural History in having representative specimens kept in New York, the proposed agreement is so worded as to still make possible the transport of the bulk of the collection to America for scientific study on the condition that representative duplicates of each species shall be returned to China which together with the casts (of those specimens which have no duplicates) will constitute a complete representation in China of the whole fauna collected.

As it was admitted by both sides from the beginning that some Chinese paleontologist shall take part in the field work on one hand, and on the other hand the bulk of the collection should be scientifically studied and described in America, the difficulty was immediately felt that there would be no scientific interest for the Chinese specialist who would only help in the collection and have no opportunity of taking part in the real scientific work.

To remedy this difficulty, it was thought desirable that one Chinese specialist shall be offered the opportunity of going to the American Museum to describe a part of the material which he has helped to collect.

These proposed terms with the underlying ideas were put before the leaders of the Central Asiatic Expedition on March 26. These gentlemen, after some discussion and explanation, agreed in principle and went on discussing the details, in the subsequent two meetings, as to how many (two or three) Chinese representatives the expedition can take and how long (one or two years) would be necessary for the Chinese paleontologist to stay in America in order to accomplish some real work. The details of these questions were also mainly agreed upon and it was already understood that the expedition was making necessary preparations to leave, when Dr. Andrews, at the meeting of April 16 which was understood to be final, brought up the proposal that Article IV of Clause A (providing for the leaving in China of specimens which can be readily recognized as duplicates without special study) should be entirely omitted unless an additional clause be inserted that Dr. Granger is to be the only judge of what is duplicate or not. In an extremely conciliatory spirit, the representatives of the committee assured Dr. Andrews that the committee already admits the necessity of studying most of the specimens in America; that the scientific authority of Dr. Granger in this matter is unquestioned by the Chinese committee, and in any unlikely case of divergence of views full consideration will be paid to his opinion. But they felt it beyond their power to accept any insertion which will admit absolutely no saying from Chinese side although they were quite willing to consider any other wording. On this point Dr. Andrews refused further discussion.

The committee was surprised to read the news in Wednesday's newspapers evidently given out from Andrews which is in many points contrary to facts. The committee has fully considered the scientific interest of the American Museum; there was never question of paying as many as three Chinese scientists in America, and there was absolutely no new demand besides the agreement provisionally reached a fortnight ago. The committee can not but feel sorry for the deadlock of the negotiations for which only the unexplainable sudden change of Dr. Andrews' attitude is responsible and the utter distortion of facts in his news communication which will not contribute to mutual good feeling.

SIN PINGCH'ANG,
General Secretary
For the Chinese Committee of the Preservation of Archeological Objects

THE NATIONAL INSTITUTE OF PSYCHOLOGY

THE National Institute of Psychology was incorporated in the District of Columbia on June 29, 1929, by Hugh S. Cumming, E. E. Slosson and Knight Dunlap. The steps which led up to this incorporation were initiated by the Conference on Experimental Psychology, held at Carlisle, Pennsylvania, under the auspices of the division of anthropology and psychology of the National Research Council, and composed of representatives of the principal psychological laboratories in the United States, which included among its final recommendations the following:

> *Be it resolved:* That the Conference on Experimental Psychology of the National Research Council approve in principle the establishment of a National Laboratory of Experimental Psychology, and the establishment of further Institutes of Psychology connected with universities.
>
> To this end, be it further resolved, that this conference recommends that a Committee on Experimental Psychology be set up in the Division of Anthropology and Psychology of the National Research Council to promote intensive and continuous research on fundamental problems.
>
> It shall be the duty of this committee:
>
> 1. To formulate plans and to seek financial support for a National Laboratory of Experimental Psychology on a scale adequate for attacking fundamental problems of psychology calling for extensive equipment and special technique.
> 2. To support the efforts of universities to establish research institutes of psychology, each of which may be expected to study one of the fundamental problems of experimental psychology.
> 3. To consider any other means for the promotion of psychological research.

This resolution was duly presented to the division at its annual meeting on April 21, 1928, and approved by the following actions:

> *Voted:* That the chairman of the division recommend the appointment of a Committee on Experimental Psychology under the division.
>
> *Voted:* That the recommendation of the Carlisle Conference, looking toward the establishment of a National Laboratory of Psychology, preferably in the District of Columbia, and the furthering of psychological institutes under the auspices of the universities be approved.

The first of these two votes was in accordance with the usual procedure by which the establishment of new committees is recommended by the chairman of the division to the executive board or the interim committee of the council. It was understood by the division that while the National Research Council might be willing to hold funds temporarily for the laboratory, it could not, in consistency with its general policy, undertake the organization or control of any such laboratory.

The committee on experimental psychology was duly established, its members being Madison Bentley, Harvey A. Carr, Knight Dunlap, Samuel W. Fernberger and F. Lyman Wells. At a meeting held on April 11, 1929, the committee agreed upon the organization and incorporation of a National Institute of Psychology as a controlling body for the projected National Laboratory.

This action was reported to the annual meeting of the division on April 12, 1929, but no further action was requested from the division, since it seemed that the division had gone as far as it could officially go in endorsing the project.

The details of incorporation were left by the committee to the chairman of the division, the committee itself being precluded from acting as incorporators by the requirement of the District of Columbia that the majority of incorporators must be residents of the district. The committee prepared for the incorporators an initial list of members and cooperated with the chairman and the legal adviser in drawing up a set of by-laws for the institute.

The incorporators met on August 30, in Washington, elected the initial list of members which had been prepared by the committee, elected a board of directors, consisting of the members of the committee on experimental psychology, with a president and secretary to serve until the organization of the board, and adopted the by-laws which in principle and in most details had been approved by the committee. The incorporators thereby relinquished their control over the corporation.

The directors met at New Haven on September 4, 1929, and elected officers as follows: *President,* Knight Dunlap; *vice-president,* F. Lyman Wells; *secretary and treasurer,* S. W. Fernberger. These with Madison Bentley and Harvey A. Carr are the board of directors.

The essential provisions of the by-laws (which may be modified after one year) are as follows:

1. Active membership is restricted to fifty, who shall be qualified by research in experimental psychology.
2. Members beyond the initial group elected by the incorporators must be nominated by 80 per cent. affirmative vote of the active members, and elected by the directors.
3. Members reaching 60 years of age cease to be active, and become honorary members. Other honorary members may be elected by the same procedure as that for the election of active members.
4. Active members who fail to publish significant research within a certain period of time become associate members.

These provisions are somewhat drastic, and are frankly experimental. It is easy to widen qualifications for membership, extend age and number limits and otherwise lessen restrictions when such lessening is clearly advisable. The opposite procedure, however, is much more difficult, and the committee desired to be on the safe side.

It should be said that before setting the numerical limit of 50 (which includes associates, but not honorary members), the committee canvassed the list of American psychologists, and taking into account the ages of the initial group of members and their dates of elevation to honorary membership, saw no prospect of the membership of 50 being filled for many years. The nominating requirement of 80 per cent. affirmative vote of the members may be too high: that point can be determined in practice.

The authority of the directors, as granted by the articles of incorporation, is high and may be said to be autocratic. This feature is the result of competent legal advice, which has pointed out that no corporation otherwise constituted could command financial confidence, or be able to function adequately in case of war or other emergency. It is clear, however, that the affairs of the institute are really in the hands of the membership as soon as the members are organized, and no directorate would be able to maintain a policy opposed to the will of the membership. The institute, in short, is republican, so that the members are guaranteed the continual dignity and responsibility of the institute and satisfactory guardianship of its property and policies.

The ultimate plan of the directors of the institute, subject to approval by the membership, is the establishment of a laboratory either in the District of Columbia or immediately adjacent thereto, in which there shall be provision for a permanent staff and adequate equipment for research in human and animal psychology. It is deemed possible through such provision not only to undertake the solution of problems too large in time and equipment required to be handled by university laboratories, but also to foster the development of a real comparative psychology. Provision for temporary staff appointments are also contemplated, so that integration with other laboratories will be promoted, and individuals can be offered opportunities to complete at the National Laboratory research which has been begun elsewhere. If, eventually, temporary appointments from abroad can be provided, the institute should become maximally efficient in the promotion of research in the United States. The institute is legally empowered to advance scientific work in psychology by publication and all other appropriate means.

KNIGHT DUNLAP

THE BRIGHT METEOR OF JANUARY 3, 1930

AT approximately 5:50 A. M., Eastern Standard Time, on January 3, a brilliant meteor or fireball flashed across southern Ontario and northern Ohio, and possibly regions farther south. It was seen by the writer from Ann Arbor, Michigan, and was reported from Cleveland as having been seen in western Pennsylvania. It left a reddish train, parts of which were visible for some seconds. The brilliancy of the meteor lasted perhaps three seconds as seen by the writer, and was equal to that of a very bright flash of lightning, the surrounding landscape being strongly illuminated. The writer did not see the entire path, because a building obstructed the view. An observer in Detroit states that the meteor burst into a number of fragments. His data, coupled with the writer's observations, would appear to indicate that the burst occurred over central or southern Ohio.

The writer is desirous of obtaining as much information as possible concerning this body. Such data should include the altitude and azimuth of the point of burst or of the mid-point or ends of the luminous train or all these, if possible. The apparent angle between the path or train and the vertical should be given. The best kind of observation would be a plot of the apparent path of the meteor relative to identifiable stars. Even rough values, if obtained at points one hundred miles or more from Ann Arbor, would be of value, and observations of the meteor passing directly overhead, or nearly so, are also desirable. It is evident that a person need not know even the barest rudiments of astronomy in order to furnish some of the data mentioned. Undoubtedly many who saw it have refrained from giving any notice of it because they feel that their observations would be of no value.

If the observer recalls the place where he stood when the meteor was seen and remembers the relation of its path to the neighboring terrestrial objects, he may be able to determine fairly reliable data by going again to the point of observation with a transit or clinometer and compass, or even with no instruments at all except his eyes and a little good judgment. From some localities even the bare statement that the meteor was seen to burst in the northern sky would be of value, since it would set a limit to its flight.

If enough information can be obtained it should be possible to calculate the orbit of the meteor, both relative to the earth and to the sun. The point of burst especially should be well determined, and it might be possible to indicate within rather close limits the area within which fragments might be found.

DEAN B. MCLAUGHLIN

DETROIT OBSERVATORY,
ANN ARBOR, MICHIGAN

SYNCHRONOUS FLASHING OF FIREFLIES

SYNCHRONOUS flashing of fireflies is noted in the Philippines December 6, and with the seven preceding notes published in SCIENCE since E. S. Morse raised the question February 4, 1916, the phenomenon has been frequently recorded. Since none of these references mention Mexico I call attention to Terry's Guide, page 568:

"A singularly beautiful insect is found in and near the Palonque ruins." Then follows a quotation from early Spanish chroniclers and statements: "This insect, which is common to the tropical forests bordering the Gulf of Mexico, belongs to a family of beetles known as the Elateridae, and is called by the Indians cucuji. . . . The insects congregate by the thousands on certain forest trees, and as if at a given signal simultaneously flash their lights; then darken them and flash them again," etc.

R. H. MERRILL

BUSUANGA HERRE, NEW GENUS

THIS genus is distinguished from other genera of the Belonidae by the anterior extremity of the mandible, which extends beyond the snout and terminates in a thick, spongy, somewhat flexible tip, much thicker than the rest of the mandible and forming a continuation of the upper profile of the beak.

The type is *Busuanga philippina* Herre. It has been described and figured as *Tylosurus philippinus* Herre, in *Philippine Journal of Science* 35 (1928), 31, plate 2, and in *Philippine Journal of Science* 36 (1928), 228, plate 3.

Busuanga, from the island where the fish was first found. Busuanga is one of the Calamianes, an island group in the Philippines between the Sulu and China Seas.

ALBERT W. HERRE

ZOOLOGY MUSEUM,
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SCIENTIFIC BOOKS

The Problem of Krakatoa as Seen by a Botanist. By C. A. BACKER, formerly government botanist for the flora of Java. For sale by Martinus Nijhoff, The Hague. 18 by 26 cm. 299 pp.

THE volcanic island Krakatoa, devastated in 1883 by a terrific eruption, has greatly interested botanists ever since Treub published his observations on revegetation. This universal interest was due to the fact that it was considered certain that the original flora and fauna had been wholly destroyed by the eruption.

Hence it was considered that Krakatoa presented an exceedingly rare opportunity for tracing the colonization of new soil by living beings.

Backer, who has been interested in the problem for many years, having studied the new vegetation on the spot as long ago as 1908, now comes forward with a critical review of all the work that has been done on the "new" flora.

As, unfortunately, so often happens in the progress of science, Backer now finds that the observations of the first years upon which all subsequent work must be predicated were neither exact enough nor extended enough to support the conclusions that have been built upon them. Treub and the other early workers apparently assumed, without considering it necessary to examine thoroughly, that so violent an eruption must necessarily have destroyed all vegetation and left the island sterile throughout. Certainly they did not explore all parts of the island or even representative habitats of all sorts but confined their attention to relatively small areas in the lowland. And certainly they did not submit any detailed data supporting their assertions of complete sterilization.

Backer now points out a number of circumstances which make it seem probable that the new vegetation consisted largely of holdovers rather than entirely of immigrants.

His reasons for this conclusion are three:

> (1) The hot ejecta never accumulated on the steeper parts of the island but rolled off to the flats leaving the slopes relatively little injured.
>
> (2) Plants large enough to be observed from the deck of a ship were seen on the slopes within three years after the eruption. (These were not examined close up and it was many years before the volcano was actually ascended.)
>
> (3) While the flora of the strand demonstrably consisted of water-borne pioneers, the flora of the heights was of very different complexion. No careful studies have ever been made to determine its origin.

The ferns which played an important part in the colonization of the lowland back of the strand may, Backer thinks, quite as likely have come from adjacent cliffs as from a distance.

As to the probable weight of Backer's criticism the reviewer may add that his own experience at Katmai showed that the most careful investigation is necessary before it may be safely concluded that a volcanic territory has been completely sterilized. In Katmai Valley abundant plants of many species came up from old roots in places which had been buried under several feet of ash for three years and were later cleared by flood waters. One such habitat was found well up the slopes of the volcano and others at its foot. Certainly we would not have believed it possible for plants to survive under such conditions if we had not demonstrated it. In view of the similarity in character of the two eruptions it would seem likely that plants also survived here and there on Krakatoa.

As a result of his critique Backer concludes:

> (1) It is not at all proved that by the eruption of 1883 all vegetable life on Krakatoa was destroyed.
>
> (2) Even if this could be proved, we know—with the exception of the littoral flora—nothing at all about the manner in which the new vegetation has appeared. Only guesses without scientific value have been made but no reliable observations or experiments.
>
> (3) Therefore, the Krakatoa problem can neither now nor in the future either be proved or solved and is of no importance at all for botanical science.

ROBERT F. GRIGGS

THE GEORGE WASHINGTON UNIVERSITY

Die Biologie der Moore. By O. HARNISCH. Bd. VII of Thienemann's Binnengewässer, 1929, 146 pp., 3 pl., 30 figs. Published by E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart.

A MOOR is defined as a continuous tract of land from whose moisture-loving plants there is forming (a living moor) or has formed (a dead moor), under the influence of terrestrial or telluric water, a massive accumulation of decomposition products rich in carbon. European moors have been studied extensively during the past two decades, and a considerable volume of literature dealing with this field of science has been published. The present volume gives a good résumé of the more important results contained in these publications. The ecological phases of the subject are especially emphasized.

Moors are discussed under two general heads, (1) as habitats and (2) the plant and animal societies that are found therein. The character of a moor as a habitat is determined largely by the character of the water supply; that is, whether the water holds a large or a small amount of mineral salts in solution which will serve as plant food material. The quantity of salts, in turn, is dependent upon the character of the rocks with which the water has come into contact. The amount of salts also determines whether the moor is eutrophic or oligotrophic. The abundance of the water supply, the temperature, the light intensity and the hydrogen-ion concentration are important factors also. By means of the method of pollen analysis the history of a moor from the time of its formation to its present stage may be ascertained.

Under life societies, the author takes up first the life of the ponds and pools that occur in moors. The algae, protozoa, rotifers and crustacea of the open waters are considered as well as the bottom fauna. The population is made up of ubiquitous forms and of those that are rather closely restricted to habitats of this character.

The moss turf usually holds a great deal of water which is well populated with a great variety of characteristic forms of algae, rhizopods, Turbellaria, rotifers and nematodes. In high moors the population is much smaller and the variety of organisms is rather limited. There is also a characteristic air-breathing fauna which shows considerable variation in composition in the different kinds of moors.

A bibliography of 178 titles is given.

C. Juday

Wisconsin Geological and Natural
History Survey

Icones Plantarum Sinicarum. By H. H. Hu and W. Y. Chun. Fasc. 2, pp. 1–50, pl. 51–100. The Commercial Press, Shanghai, 1929.

This folio work prepared under the auspices of the Science Society of China and the department of botany, National Central University, Nanking, reflects distinct credit on both the authors and the publishers. Detailed descriptions in both English and Chinese of fifty indigenous species, together with important synonyms, geographic distribution, etc., are given. The figures, drawn natural size with enlarged details of the essential parts, are well executed and graphically represent the several species, many of which are here figured for the first time. The work is one that should be consulted by all botanists interested in the Chinese flora and in the preparation of monographic treatises.

E. D. Merrill

University of California

SCIENTIFIC APPARATUS AND LABORATORY METHODS

CHART ILLUSTRATING THE HISTORY OF BIOCHEMISTRY AND PHYSIOLOGY

May I be permitted to call the attention of the readers of Science to a recently published chart dealing with the history of the twin sciences of physiology and biochemistry?

This chart, which has been reproduced from the original by a lithographic process, gives a two-dimensional account of the historical development of these and cognate sciences. The arrangement is that of a graph, the vertical scale being in years and running from 1450 to 1900 with ten-year intervals marked off by horizontal lines. The lives of individual investigators are represented by continuous vertical lines beginning at the date of birth and ending at the date of death. Beside each such line is the name of the investigator in capital letters, with special signs indicating the university in which he was professor or the town where he worked. The vertical divisions group the investigators into anatomists, physiologists, biochemists, chemists, zoologists and philosophers. Diagonal wavy or dotted lines indicate relationships, controversies and succession in professorial chairs, and in this way also the main streams of intellectual influence are shown. At the date of publication of an important book or memoir, a thin horizontal line leaves the life-line of the investigator in question and leads to the title followed by a short description of the book. In addition to these descriptions there are quotations and notes interspersed throughout. In order to give an idea of contemporary events, the lives of men not biologists are shown in a separate column, *e.g.*, Galileo, Cervantes, Montaigne, Erasmus, Browne. Certain wars are also represented by vertical lines; the founding of associations such as the Royal Society is marked, and the beginnings of scientific journals noted. Before 1450 there is no regular time-scale, but the achievements of classical antiquity, the Hellenistic age and the dark ages are briefly referred to. The chart may be said to give a wide and detailed survey of the history of biochemistry and physiology, but its interest for biologists in general is considerable, as before 1800 the fields of study were not clearly differentiated, and until then the chart is practically a history of biology as a whole.

Joseph Needham

Biochemical Laboratory,
University of Cambridge

FIXING THIN BLOOD SMEARS FOR STAINING WITH IRON HEMOTOXYLIN AND WITH GIEMSA'S STAIN

The writer was unable to make satisfactory iron-hematoxylin preparations of blood smears that were fixed by the methods commonly in use because the erythrocytes retained this stain very tenaciously and, when they were finally destained, the chromatin of intracellular blood parasites was found to be likewise destained. The following modifications of well-known methods have, however, been made with success. Thin smears were dried in the same way as for Giemsa's preparations and fixation was completed by immersion in Schaudinn's alcoholic sublimate solution without acetic acid. The erythrocytes did not then take the hematoxylin, whereas the intracellular blood parasites stained well. In slides thus treated the cytological details of *Babesia bigemina* were brought out very clearly. Good results with iron-hematoxylin have also been obtained following wet fixation by formaldehyde. For this purpose the thin smears were dropped into a coplin staining jar that contained about 3 cc of 40 per cent. formalin and were then treated with alcoholic sublimate as for dried smears. The erythrocytes took the stain but were destained easily. It has been found difficult to make good dried smears of the blood of anemic cattle. This was especially the case when a high relative humidity retarded drying. The erythrocytes of such smears appeared full of air bubbles when examined under oil immersion. This difficulty has been overcome by the use of the wet formaldehyde fixation described above. Blood and blood parasites thus fixed stain well in Giemsa's.

CHAS. W. REES

LOUISIANA EXPERIMENT STATION,
JEANERETTE

SPECIAL ARTICLES

A NEW BASIS FOR FERTILIZER EXPERIMENTS

EARLY in this century, Mitscherlich, the German experimenter of Königsberg, had discovered that the equation expressing the relation between yield of a crop and increase in the amount of a growth factor made available to the crop has the form

$$y = A(1-e^{-kx}) \qquad (1)$$

in which y is yield per acre, x is the quantity of the growth factor available, A is the maximum yield obtainable by the use of any amount of the factor and k is a constant.

Some years later, the writer, without knowledge of Mitscherlich's work—I was not then interested in this field of research—discovered that this law has the form

$$y = A(1-R^x) \qquad (2)$$

in which y, A and x have the same significance as in (1), while R is the ratio of a decreasing geometric series the terms of which are the increments of y corresponding to successive equal increments in x. I was also able to show that the e^{-k} of the Mitscherlich formula has the same significance as the R of my formula.

The German mathematician Baule pointed out, and Mitscherlich confirmed the same experimentally, that when two or more growth factors are varied simultaneously, this equation assumes the form

$$y = A(1-R_1^{x_1})\,(1-R_2^{x_2})\,(1-R_3^{x_3}) \qquad (3)$$

in which x_1 represents the quantity of the first growth factor, R_1 the ratio of the series of increments in yield due to increases in this factor; x_2 and R_2 have a similar relation to the second growth factor; x_3 and R_3 to the third, and so on.

Equation (3) applies to plants grown in water or sand cultures, in which the only amounts of the first, second, etc., factors available are those supplied by the experimenter, and which are therefore measurable directly. The purpose of the present preliminary note is to point out that in field experiments, on a soil containing n, p and k available units per acre of nitrogen, phosphoric acid and potash respectively, the above formula takes the form

$$y = A(1-R_1^{n+x_1})\,(1-R_2^{p+x_2})\,(1-R_3^{k+x_3}), \qquad (4)$$

and, further, to show how, with results from three fertilized plots, with suitable check plots, with sufficient replication to make the results reliable and with sufficient repetition from year to year to eliminate seasonal variations in yield, it is easily possible to calculate the values of the four constants A, *n*, p and k (the constants R_1, R_2 and R_3 are known from Mitscherlich's work) in equation (4), and then to use this equation for calculating the yield to be expected from the application of any quantities whatever of the three fertilizer ingredients, nitrogen, phosphoric acid and potash. The addition of other growth factors to the list requires only the addition of a single experimental plot for each factor, and, of course, the determination of the value of R for that factor. Mitscherlich has shown that the value of R is the same for all crops and all soils for a given growth factor when the unit of the growth factor is properly chosen.

The fertilizer treatment necessary on the four plots (three fertilized and one check plot) is shown in the following tabular statement:

	Units of fertilizer per acre			
	N	P_2O_5	K_2O	Yields
Plot 1.	a	0	0	y_1
" 2.	0	b	0	y_2
" 3.	0	0	c	y_3
" 4. (Check)	0	0	0	y_4

in which a, b and c are the respective amounts of nitrogen, phosphoric acid and potash, in units of 100 lbs. per acre, applied in fertilizer on the plots. The values of a, b and c should be such as to give considerable effect on yield so as to lessen the percentage of experimental error, yet should not be so large as to cause the results to lie far out on the nearly horizontal portion of the yield curve. These quantities are best determined by preliminary tests with the growth factors in question.

The four observation equations which, by proper substitution in (4), these four experimental plots give are

$$\text{Plot 1.}\quad y_1 = A(1-R_1^{n+a})\,(1-R_2^{p})\,(1-R_3^{k}) \qquad (5)$$
$$\text{“ 2.}\quad y_2 = A(1-R_1^{n})\,(1-R_2^{p+b})\,(1-R_3^{k}) \qquad (6)$$
$$\text{“ 3.}\quad y_3 = A(1-R_1^{n})\,(1-R_2^{p})\,(1-R_3^{k+c}) \qquad (7)$$
$$\text{“ 4.}\quad y_4 = A(1-R_1^{n})\,(1-R_2^{p})\,(1-R_3^{k}) \qquad (8)$$

Dividing (5) by (8)

$$\frac{y_1}{y_4} = \frac{1-R_1^{n+a}}{1-R_1^{n}}$$

From this equation the value of n is easily found.

In a similar manner the values of p and k are found. The value of A is then found by substitution of the known values of n, p and k in (8). Equation (4) is then available for calculating the yield to be expected from any amounts of nitrogen, phosphoric acid and potash applied as fertilizers.

This matter will be presented in detail in a paper soon to be offered for publication.

W. J. SPILLMAN

WASHINGTON, D. C.

THE EFFECT OF UNILATERAL SECTION OF THE MIDBRAIN UPON COSTAL MOVEMENTS OF RESPIRATION

I WISH to add to an earlier statement[1] some recent results of unilateral section of the midbrain combined with unilateral division of the dorsal roots of the thoracic spinal nerves.

Cats were used throughout the experiments. Respiratory movements were recorded by tambours attached to Crile stethographs. One stethograph placed well up on the chest measured costal movements; the other, at the level of the diaphragm, measured diaphragmatic movements.

Experimental procedures and results were as follows: (1) Section of the dorsal roots of the spinal nerves in the thoracic region of one side, followed by section behind the inferior colliculus of the opposite side. (2) Section behind the inferior colliculus of one side, followed by section of the dorsal roots of the spinal nerves of the opposite side. (3) Section of the dorsal roots of one side, and of the inferior colliculus of the *same* side.

(1) Unilateral section of the dorsal spinal nerve roots in the thoracic region produced some slowing of the respiratory rate and some diminution in amplitude of the costal respiration, but neither of these changes was as marked as when the dorsal roots of both sides were divided. Complete cessation of the costal movements was observed on the side on which section of the dorsal roots had been done. The movements of the other side were unchanged, but naturally the amplitude recorded was not as great as normal.

In doing unilateral section of the midbrain behind the inferior colliculus, the skull was trephined over the tentorium, and, guided by the tentorium, a knife was slid perpendicularly down its caudal surface, cutting the midbrain just below the inferior colliculus. Hemorrhage was controlled by means of bone wax. The extent and location of the lesion were determined at autopsy. The result of unilateral section was to slow somewhat the respiratory rate and, in some cases, to diminish costal respiration, particularly on the side of the lesion. Diaphragmatic respiration was adequately maintained at all times. Unilateral section of the midbrain below the inferior colliculus, then, appears not to interfere greatly with the respiratory rhythm.

When, however, section behind one inferior colliculus is followed by section of the dorsal roots of the thoracic nerves *on the opposite side*, costal respiration of both sides disappears, such slight excursions of the tambour lever as are shown being induced by the diaphragmatic contractions.

(2) When the procedures are reversed, the same result is obtained as in the preceding series. True costal respiration disappears.

(3) When both operations are done on the same side, costal respiration on that side only disappears.

These results appear to show that: (1) The central station in the midbrain for afferent respiratory impulses from the dorsal roots of the spinal nerves is ipsilateral. (2) Costal respiration only is affected by section of the dorsal spinal nerve roots, or by section behind the inferior colliculus.

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COLLEGE

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[1] F. H. Pike and H. C. Coombs, SCIENCE, 56: 691–692, 1922, and the papers there cited.

BOOKS RECEIVED

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GIESEN, JOHN, and THOMAS L. MALUMPHY. *Backgrounds of Biology.* Pp. x + 278. 66 figs. Bruce. $2.50.

HORSLEY, J. SHELTON. *Research and Medical Progress and Other Addresses.* Pp. 208. Mosby. $2.00.

NAISH, WILLIAM A., and JOHN E. CLENNELL. *Select Methods of Metallurgical Analysis.* Pp. xii + 495. Wiley. $7.50.

Structure of Typical American Oil Fields. Volume II. Pp. xxiii + 780. 4 plates. 231 figs. American Association of Petroleum Geologists, Tulsa, Oklahoma.

SPECIAL ISSUE CONTAINING REPORTS OF THE DES MOINES MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND ASSOCIATED SOCIETIES. EDITED BY BURTON E. LIVINGSTON, PERMANENT SECRETARY.

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

REPORTS OF THE DES MOINES MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND ASSOCIATED SOCIETIES

GENERAL FEATURES

THE Des Moines meeting of the American Association for the Advancement of Science was held from Friday, December 27, 1929, to Thursday, January 2, 1930. This was the eighty-sixth meeting of the association and the second one to be held in the state of Iowa, the first having occurred at Dubuque in August, 1872. The preliminary announcement of the Des Moines meeting appeared in a special issue of SCIENCE for November 29, 1929. The sessions of the association and the associated societies were nearly all accommodated in hotels and other down-town buildings, all within a few blocks of one another. There was no snow and the weather throughout convocation week was uniformly fine and unusually warm for the season. Arrangements and facilities were generally unsurpassed and the meeting was successful in every way.

The president for this meeting was Robert A. Millikan, director of the Norman Bridge Physical Laboratory, of the California Institute of Technology, at Pasadena. As most readers know, President Millikan is one of the greatest leaders in physical research and in the advance of science and education. On Sunday afternoon he delivered a remarkably valuable and inspiring address on the importance of science to humanity. It was given in the Shrine Temple auditorium, before a very large audience. This address appears in the February issue of *Scribner's Magazine*.

REGISTRATION

Eighteen hundred and eighty persons registered at the Des Moines meeting, but the actual attendance was much larger. The residence distribution of those who registered is shown in the accompanying list. Altogether, about one hundred and ninety scientific sessions were held and about twelve hundred and thirty papers and addresses were delivered. These were distributed among the sciences approximately as follows: Mathematics, 48; physics, 60; chemistry, 18; astronomy, 16; geology and geography, 40; zoology, 305; botany, 263; ecology, genetics, etc., 94; anthropology, 14; psychology, 35; social and economic sciences, 21; historical and philological sciences, 9; engineering, 21; medical sciences, 16; agricultural sciences, 204; education, 38; science in general, 24. Many society dinners, luncheons and smokers were held, with excellent attendance.

REGISTRATION AT DES MOINES BY STATES AND PROVINCES

Alabama	6	Nebraska	74
Arizona	4	Nevada	1
Arkansas	7	New Hampshire	4
British Columbia	2	New Jersey	17
California	22	New Mexico	2
Colorado	26	New York	78
Connecticut	14	North Carolina	6
Delaware	3	North Dakota	10
District of Columbia	44	Ohio	58
England	1	Oklahoma	24
Florida	6	Ontario	5
Georgia	2	Oregon	4
Idaho	1	Pennsylvania	38
Illinois	170	Philippine Islands	2
Indiana	51	Porto Rico	2
Iowa (Des Moines excluded)	311	Quebec	2
		Rhode Island	2
Des Moines	262	South Carolina	1
Kansas	76	South Dakota	12
Kentucky	11	Tennessee	16
Louisiana	12	Texas	28
Maine	9	Utah	4
Manitoba	5	Vermont	0
Maryland	21	Virginia	8
Massachusetts	24	Washington	6
Michigan	65	West Virginia	6
Minnesota	97	Wisconsin	107
Missouri	95	Wyoming	6
Mississippi	11		
Montana	4	Total	1,880

THE LOCAL COMMITTEE AND REPRESENTATIVES OF SECTIONS

The General Local Committee for the Des Moines meeting was made up as follows:

D. W. Morehouse, president of Drake University, *general chairman of the local committee.*

J. W. Studebaker, *vice-chairman;* superintendent of the Des Moines public schools.

L. B. Spinney, *vice-chairman;* Iowa State College, Ames, Iowa.

G. E. Hamilton, *secretary of the general committee and chairman of the special committee on hotels, dinners, etc.;* Des Moines Convention Bureau.

Walter L. Bierring, *chairman of the special committees on finance and local membership;* 1210 Bankers Trust Building.

T. J. Edmonds, *chairman of the special committee on news service;* Iowa Tuberculosis Association, 518 Frankel Building.

E. C. Lytton, *chairman of the special committee on personnel and registration;* Drake University.

Henry Nollen, *chairman of the special committee on reception and entertainment;* Equitable Life Insurance Company of Iowa, Equitable Building.

C. L. Pye, *chairman of the special committee on meeting places, equipment and exhibits;* Iowa State Teachers Association, 416 Shops Building.

R. C. Woolman, *chairman of the special committee on local transportation, information, signs, etc.;* Independent School District, 629 Third St.

The following named persons served as local representatives of the several sections of the association:

Section A (Mathematics), I. F. Neff, Drake University, Des Moines.

Section B (Physics), P. S. Helmick, Drake University, Des Moines.

Section C (Chemistry), A. J. Rider, Drake University, Des Moines.

Section D (Astronomy), D. W. Morehouse, Drake University, Des Moines.

Section E (Geology and Geography), Jas. H. Lees, Iowa Geological Survey, State House, Des Moines.

Section F (Zoological Sciences), L. S. Ross, 1308 27th St., Des Moines.

Section G (Botanical Sciences), I. E. Melhus, Iowa State College, Ames.

Section H (Anthropology), Sherman Kirk, Drake University, Des Moines.

Section I (Psychology), R. H. Sylvester, Drake University, Des Moines.

Section K (Social and Economic Sciences), Herbert W. Bohlman, Drake University, Des Moines.

Section L (Historical and Philological Sciences), Olynthus B. Clark, Drake University, Des Moines.

Section M (Engineering), Anson Marston, Iowa State College, Ames.

Section N (Medical Sciences), John H. Peck, 1222 Bankers Trust Bldg., Des Moines.

Section O (Agriculture), Mark Thornburg, State House, Des Moines.

Section Q (Education), W. F. Barr, Drake University, Des Moines.

Representative for Organizations Not Related to Any Particular Section, Jean Carroll, Meredith Publications, Des Moines.

The general committee and its subcommittees, aided by the local representatives, performed a very fine service to American science in caring for the innumerable details of arrangements for the meeting. That this meeting occurred in Des Moines was primarily due to the efforts of Dr. D. W. Morehouse, president of Drake University, who first presented invitations from Des Moines at the second Toronto meeting, in December, 1921. In his proposal for a meeting in Des Moines Dr. Morehouse was immediately supported by the Iowa Academy of Science, which is affiliated with the American Association, by the Des Moines Chamber of Commerce, by his own Drake University and by the City of Des Moines and its institutions and organizations, as well as by the local press and many people of Des Moines. Mr. George E. Hamilton, secretary of the Des Moines Convention Bureau, gave very freely of his time and energy through the months preceding the meeting, acting as secretary of the general local committee and as chairman of the subcommittee on hotels. The convention bureau's staff devoted themselves to the work of preparing for the meeting. The great devotion of the chairmen of the subcommittees is greatly appreciated. Each of these chairmen had special charge of a portion of the preparations and a fine spirit of very successful cooperation was shown. Drake University and the Iowa Academy of Science were the prime movers in making this meeting possible. The Iowa State Legislature made a special appropriation to enable the academy to take a leading part in underwriting the local expenses. But Dr. Morehouse said that the host for the meeting was really the City of Des Moines and the State of Iowa. The well-known Iowa State College aided greatly, and several sessions of the meeting were actually held in the nearby city of Ames, where the college is located.

THE A. A. A. S. PRESS SERVICE AND THE PRESS

The Press Service of the American Association, a newly organized service of which Mr. Austin H. Clark, of the U. S. National Museum, is director, has operated throughout the year in the very important work of bringing science news to the people through the newspapers. For more than a month before the meeting Mr. Clark devoted a large part of his energy and interest to the exacting task of preparing press releases of the manuscripts of papers that were to be delivered at Des Moines. As in recent years, the permanent secretary's office sent a special request to each person whose name appeared in the program manuscripts as these came from the society and section secretaries, each author being asked to send immediately two copies of his paper, or at least two copies of an abstract, for use by the Press Service. A very large number of those who presented contributions and addresses at Des Moines were prompt in complying with this request and an unusually large amount of exceptionally excellent material was in Mr. Clark's hands several weeks before the opening of the meeting. This material was worked over and mimeographed when necessary, the release date being clearly marked in each instance, and the resulting newspaper releases were made available to the representatives of Science Service and the other news organizations in time so that unusually good stories were prepared and distributed to the great dailies long before the papers were actually presented at the meeting.

The Press Service of the association had the cordial cooperation of Mr. Watson Davis and the other members of the staff of Science Service, in the direction of which the American Association is joined with the National Academy of Sciences and the National Research Council. The representatives of the other great press agencies were also very cordial and helpful in their cooperation, as were also the representatives of many newspapers of Des Moines and other cities. Mr. T. J. Edmonds, of the Iowa Tuberculosis Association, was chairman of the local subcommittee on news service, and his aid and cooperation are greatly appreciated. The news of this meeting took a very prominent place in the local newspapers both before and during the meeting period and the meeting was adequately treated in a very large number of newspapers throughout the United States and Canada. The association is engaging increasingly in this important feature of its work, to aid in the distribution of science knowledge among the people, and it greatly appreciates the aid and cooperation of the press all over the land.

THE GENERAL PROGRAM

The General Program of the Des Moines meeting, a book of 256 pages, was available on the morning of Friday, December 27, at the registration offices, in the Shrine Temple. It contains the usual program material, including the special scientific programs of over thirty independent organizations that met with the association this year. As in recent years, there is a valuable index of authors of papers and addresses and a very useful summary of events by days. These annual programs of the association meetings furnish reliable indications of the progress and trend of science from year to year. Copies of the Des Moines program may be had free, as long as the supply lasts, in respanse to requests sent to the permanent secretary's Washington office.

Dr. Sam F. Trelease, of Columbia University, secretary of the association council and program editor for the permanent secretary's office, was in charge of publication. He was again very ably assisted by Mrs. Helen M. Trelease. They devoted themselves to this work for more than a month previous to the opening of the meeting, spending the last ten days at Des

Moines. To the secretaries of the societies and sections, who supplied the manuscripts for the special programs, the association is very grateful.

THE GENERAL EXHIBITION

A large number of makers of scientific apparatus and materials and publishers of scientific books aided in making the Des Moines meeting successful by exhibiting their wares in the general exhibition, which was exceptionally well housed on the lower floor of the Shrine Temple. Science workers derive much benefit and pleasure from the annual exhibitions, which have become an important feature of the association meetings. A list of the firms that took part in the exhibition (E) or had advertisements in the program book (P), or both (E, P), is given below.

Bausch and Lomb Optical Co. (E, P)
P. Blakiston's Son and Co. (E)
Brooklyn Botanic Garden (P)
Central Scientific Co. (E, P)
Chicago Apparatus Co. (E)
Clay-Adams Co. (E, P)
Commission on Standardization of Biological Stains (P)
Denoyer-Geppert Co. (E)
H. Eisenstein and Co., Inc. (P)
Encyclopædia Britannica (E)
Julien P. Friez and Sons, Inc. (P)
General Biological Supply House (E, P)
Kewaunee Manufacturing Co. (P)
Kny-Scheerer Corp. (P)
Leeds and Northrup Co. (E)
E. Leitz, Inc. (E, P)
B. Login and Son, Inc. (P)
Open Court Publishing Co. (P)
Schwartz Sectional System (E)
Spencer Lens Co. (E)
Charles C. Thomas (E)
Triarch Botanical Products (E, P)
D. Van Nostrand Co. (E)
W. M. Welch Scientific Co. (E, P)
B. Westermann Co., Inc. (P)
Weston Electrical Instrument Corporation (E)
Williams and Wilkins Co. (P)

Members of the association and friends of science can help the organization a great deal if they will, whenever occasion arises, encourage manufacturers and supply houses to take space in the annual science exhibition and to insert advertisements in the programs of the meetings and in the official journal, SCIENCE.

The Bausch and Lomb Optical Company and the Spencer Lens Company generously loaned many lanterns for use in the numerous session rooms. The Iowa Visual Service Bureau, of Des Moines, and Drake University loaned lanterns and motion-picture projectors, and motion-picture projectors were loaned by the Des Moines Public Schools, the Ankeny Public Schools and the Valley Junction Public Schools. To all these organizations the association and the societies are very grateful.

THE DES MOINES PRIZE

The seventh award of the American Association prize of $1,000 was made at Des Moines to Dr. A. J. Dempster, professor of physics in the University of Chicago. This prize is awarded annually to the author of a notable contribution to the advancement of science presented at the annual meeting. The funds for the prize are generously supplied by a member who does not wish his name made public. The committee on award was this year composed of the following members: Charles E. Allen, University of Wisconsin, *chairman;* P. W. Bridgman, Harvard University; Fay-Cooper Cole, University of Chicago; S. C. Lind, University of Minnesota; H. L. Rietz, University of Iowa. To these gentlemen is here expressed the gratitude of the association for their efficient and valuable service in this important and delicate part of the association's work.

Dr. Dempster's contribution constitutes an important extension of the work of the French physicist, Louis de Broglie, for which the Nobel prize in physics was recently awarded. According to the de Broglie wave mechanics small particles should exhibt the behavior of waves when reflected. The Americans, C. Davisson and L. H. Germer, of the Bell Telephone Laboratories, recently demonstrated this experimentally for electrons reflected from the surface of a crystal of nickel, and the gold medal of the National Academy of Sciences was awarded to Dr. Davisson for that contribution. Now the same thing has been shown by Dempster, for protons reflected from a crystal of calcite. So streams of electrons and streams of protons both behave like waves in some respects and like particles in other respects. This apparent paradox is of very great fundamental interest to students of the nature of matter and energy, and its various implications are now receiving much attention.

GENERAL SESSIONS AND COMPLIMENTARY LECTURES

There were many more general lectures at the Des Moines meeting than at any earlier one. In recent years the program of general lectures has received an increasing amount of attention, partly in response to a continually growing public demand for easily understood accounts of current scientific progress and partly because the specialists in the many fields of science are becoming increasingly appreciative of their need for general information about current scientific work along lines other than their own.

The general lectures at Des Moines were grouped in two series, those given at general sessions of the association and those presented as complimentary to the public. The general sessions were generally held at 4:30 in the afternoon or in the evening, while the complimentary lectures were generally given at 2:30 in the afternoon or in the evening. Many of these were held in the Shrine Temple auditorium, an unusually fine hall with ingenious arrangements for beautiful lighting effects. Space limitation prevents more than a cursory review here of those lectures.

General Sessions.—The retiring presidential address was given at the opening session, Friday evening, by Henry Fairfield Osborn, who was president of the association for 1928. His title was "The Discovery of Tertiary Man." This address has been published in SCIENCE for January 3, 1930. The general reception followed the opening session and both were very well attended.

At a general session on Saturday afternoon Dr. Fay-Cooper Cole, of the University of Chicago, gave an address on "An Anthropologist's View of Race," in which he presented an interesting discussion of how the present human races may have been produced and of the meaning of "superior" and "inferior" races.

The eighth annual Sigma Xi lecture was given at the general session Saturday evening, under the joint auspices of the Society of the Sigma Xi and the American Association. The speaker was George H. Parker, of Harvard University, whose subject was "Some Aspects of Human Biology." He considered how human improvement may be accelerated and guided, not only through improvement in the social inheritance of the individual (environment, education, opportunity) but also through the conscious restriction of undesirable germinal inheritance, as in the prevention of reproduction by individuals with marked social defects.

A general session on Monday afternoon was devoted to an address by James B. Macelwane, S.J., of St. Louis University, on "Earthquakes and What They Tell Us." His discussion brought out the causes of earthquakes as now understood and reasons why they occur more frequently in some places than in others.

On Monday evening, before a general session, W. T. Bovie gave an interesting discussion of "The Relation between the Size of the Energy Atom and Its Physiological Effect." He discussed responses of lower organisms to their radiant-energy environment, giving attention to the evolution of animal and plant adaptations that are related to radiation. Many responses are selective and attuned to specific ranges of wavelength or spectral frequency bands that represent determinate ranges of quantum magnitudes.

Two general sessions occurred on Tuesday afternoon. One of these was devoted to a symposium on "The Salary Problem," arranged by the association's Committee of One Hundred on Research, of which Rodney H. True, of the University of Pennsylvania, is secretary. Dr. True writes that this topic has been given prominence at several recent sessions arranged under the auspices of the Committee of One Hundred, because of the conviction that the question of adequate salaries is one of the prime influences exerted on research in America and that it deeply affects the general social outlook and welfare. President Robert A. Millikan occupied the chair at this symposium. William A. Noyes, of the University of Illinois, discussed "The Salary Problem as Seen by the Professor." R. Y. Stewart, of the U. S. Forest Service, spoke for Harry G. Knight, of the U. S. Bureau of Chemistry and Soils, who was absent on account of illness. His topic was "The Salary Problem as Seen by the Government Executive." A paper by Edward A. Filene, of Boston, on "The Salary Problem in its Social Implications" was read by the secretary in the absence of Mr. Filene. This symposium brought out many interesting and even startling facts concerning the generally low salaries of research workers in educational and government institutions as compared with the corresponding salaries of those engaged in industrial research and other comparable lines of work. It is expected that a fuller report of the symposium will appear in a subsequent issue of SCIENCE.

The seventh annual Josiah Willard Gibbs lecture was delivered at the other general session on Tuesday afternoon, under the joint auspices of the American Mathematical Society and the American Association. The lecturer was Irving Fisher, of Yale University, who spoke on "The Application of Mathematics to the Social Sciences." It was pointed out that there are several distinct branches of social science to which mathematics has been or may be applied: (1) pure theory, (2) the fitting of formulas to statistics, (3) correlation, (4) probabilities.

The general session of Tuesday evening was devoted to a lecture on "Glaciation—the Background of the Development of the Mississippi Valley," by George F. Kay, of the University of Iowa. The story of glaciation in the Iowa region was interestingly and clearly told, the origin of Iowa soils was shown to be definitely related to the action of ice-sheets that invaded this region in glacial times, and the dependence of present human culture on the soil was emphasized.

On Wednesday afternoon a lecture on "Some Aspects of Celestial Evolution" was delivered at a general session, the lecturer being Edwin B. Frost, of the Yerkes Observatory, of the University of Chicago. Dr. Frost's lecture dealt with the phenomena of novae, which may rise from obscurity even to the first magnitude in a day or two. It was pointed out that such outbursts are not infrequent, seeming to be due to internal explosions that blow off an outer shell of the star and are accompanied by a great expansion of luminous matter. The relation of the outbursts of novae to the time scale of celestial evolution was critically considered.

This unusual series of general sessions was closed on Wednesday evening by a lecture on "The Laws of Racing Fatigue in Men and Horses," delivered by A. E. Kennelly, of Harvard University, who discussed a remarkable general relation between going time and average speed for running, pacing and trotting horses and for walking, running, skating, rowing and swimming men. It was pointed out that the going time varies inversely very nearly as the ninth power of the average speed in all these instances.

Complimentary Lectures for the People of Des Moines.—The complimentary lectures were arranged primarily for the people of Des Moines, including school and college students. They constituted a definite contribution by the American Association toward the reliable dissemination of scientific knowledge among the people. Ten of these lectures were presented and one of them was presented twice. All were illustrated. The speakers and their topics are shown below.

"Where Iowa Gets Her Weather," by Charles F. Brooks, of Clark University; Saturday afternoon.

"Exploration for Human Origins and Migrations in the Far Northwest," by Aleš Hrdlička, of the U. S. National Museum; Saturday evening.

"The Alleged Sins of Science," by Robert A. Millikan, president of the American Association for 1929; Sunday afternoon.

"Collecting Live Animals in Africa," with motion pictures, by William M. Mann, of the U. S. National Zoological Park; Monday afternoon. This lecture and showing of the exceptionally fine motion pictures was repeated, by special request, on Tuesday afternoon.

"Our Ocean of Air: What It Is and Where It Came from," by W. J. Humphreys, of the U. S. Weather Bureau; Monday afternoon.

"The Adler Planetarium and Astronomical Museum of Chicago," by Philip Fox, of the Adler Planetarium; Monday evening.

"By Airplane to Pigmy Land" (New Guinea), by M. W. Stirling, of the Bureau of American Ethnology, Smithsonian Institution; Tuesday afternoon.

"The Living Wealth of Alaskan Waters," by Lewis Radcliffe, of the U. S. Bureau of Fisheries; Tuesday afternoon.

"Turning the Clock Back Ten Million Years," by Arthur S. Coggeshall, of the Saint Paul Institute, St. Paul, Minnesota; Wednesday afternoon.

"Clouds of Everywhere and Their Splendors," by W. J. Humphreys, of the U. S. Weather Bureau; Thursday afternoon.

BUSINESS PROCEEDINGS OF THE COUNCIL AND EXECUTIVE COMMITTEE AT DES MOINES

The executive committee met Friday forenoon and the council met in the afternoon of the same day. The council held sessions on Saturday, Monday, Tuesday and Wednesday at nine o'clock, and the executive committee held a session immediately following each of these council sessions, also a session on Sunday morning. The following items of business were transacted.

(1) The permanent secretary presented a mimeographed report on the status of membership for the year ending September 30, 1929, and for that portion of the year 1929–30 from September 30 to December 20. On September 30, 1929, the paid-up membership was 17,520, which is 2,083 more than the corresponding number for September 30, 1928. The total enrolment (including paid-up members and members one or two years in arrears) was 18,462 on September 30, 1929, which is 2,134 more than on September 30, 1928. On October 1, 1929, 327 names of members in arrears for two years were regularly dropped from the roll and 209 members resigned or died between September 30 and December 20, 1929. In the same period 851 new members were enrolled, and the total enrolment on December 20 was, therefore, 18,777.

(2) The council accepted a report from Herbert Osborn, of Ohio State University, representative of the association on the board of trustees of *Biological Abstracts*.

(3) On recommendation by the executive committee, a progress report of the Committee on Source Books in the History of the Sciences was accepted by the council. The chairman of this committee is Gregory D. Walcott, of Long Island University. The "Source Book in Astronomy" has been published and that for mathematics is to appear soon. Other source books are in preparation.

(4) On recommendation by the executive committee, a report of the Committee on Popular Science Book-lists was approved by the council. This committee, the chairman of which is Joseph L. Wheeler, of the Enoch Pratt Free Library, Baltimore, is engaged in the preparation of attractively printed lists of book titles in the several branches of science, the titles being selected as suitable for use by those who are not specially trained in science. These lists are to be made freely available to the general public and school students, through public libraries and other available means. The work is in an advanced stage.

(5) The committee on calendar reform, consisting of A. E. Kennelly (*chairman*), W. W. Campbell, A. B. Crook, Gano Dunn and C. F. Marvin, presented a report to the council, which was adopted, as had been previously

recommended by the executive committee. The report now becomes an action by the council, which follows:

A Resolution on Calendar Reform

WHEREAS, The Council of the American Association for the Advancement of Science desires to reaffirm the resolution on Calendar Reform adopted at Washington, January 2, 1925, which is worded as follows:—"*Resolved*, that the American Association for the Advancement of Science approves of any alteration in the calendar that would adjust it to modern conditions for scientific work and that the Association would welcome in this connection cooperation with other bodies such as the committees of the League of Nations that are concerned with this subject";[1] and,

WHEREAS, The Council is convinced that calendar simplification should be internationally adopted for the benefit not only of scientific work, but also of commerce and of the peoples of the earth in their daily lives, and likewise for the promotion of international and national understanding; therefore, be it

Resolved, That the Council advocates calendar simplification for international adoption as soon as may be practicable, and the calling of an international conference to report upon the best method, agreeable to all nations concerned, that will remove the serious defects of the present calendar; and favors a revision of the calendar such that the year will consist of thirteen months of twenty-eight days each and an extra day of non-week-day name, with an additional midyear leap day in leap years.

(6) The council accepted a progress report of the Committee of One Hundred on Research and the development of further plans for the work of the Committee of One Hundred was referred to the executive committee of the Committee of One Hundred, with power. The Committee of One Hundred, the secretary of which is Rodney H. True, of the University of Pennsylvania, presented a very successful symposium on "The Salary Problem," at a general session of the association held Tuesday afternoon. That symposium is briefly reported in the section on General Sessions in this issue of SCIENCE.

(7) The Committee on Place of Science in Education, through its chairman, Otis W. Caldwell, of Columbia University, presented a plan for cooperative work with secondary schools, by which it is hoped to discover and encourage students who possess capacity for scientific work. The plan was approved in principle and referred by the council to the executive committee, with power, for such further consideration and action as might be deemed necessary. The executive committee considered this project further and referred it, with power, to the executive committee of the Committee on Place of Science in Education.

(8) The permanent secretary's audited financial report and the audited report of the treasurer for the fiscal year 1928–29, together with a note by the permanent secretary on these reports, summarizing them and bringing them up to December 20, were presented to the council by distributing mimeographed copies, and the council followed the recommendation of its executive committee and accepted the reports. The council congratulated the permanent secretary's office on the excellent financial status of the association. These reports are summarized elsewhere in this issue of SCIENCE.

(9) On recommendation by the executive committee the council voted that an appropriation of $3,000 for grants for 1930 be made from the treasurer's available funds, to be allotted by the committee on grants. The allotment has been made and the list of grantees for 1930 is given elsewhere in this issue of SCIENCE.

(10) On recommendation by the executive committee three emeritus life members were elected as follows: E. L. Nichols (M78F81), H. L. Fairchild (M78F83), David Todd (M79F81). Readers are reminded that the membership formula shows the year of enrolment in the association (after the letter M) and the year of election to fellowship (after the letter F).

(11) On recommendation by the executive committee the council voted that the annual addition of $1,000 to the publication fund be discontinued, because the fund already consists of $4,536.50, which is more than it was planned to accumulate in the four-year period between the editions of the Proceedings volume. The sum of $536.50 is to be transferred from the publication fund to the generally available fund.

(12) The arrangements for the A. A. A. S. Press Service were continued for 1930 without change. It is planned that this service is to be active throughout the year, to facilitate the distribution of science news through the daily press, the radio and other available agencies.

(13) On application from Kappa Delta Pi, an honor society in education, the council voted to enroll that organization as officially associated with the American Association, related to Section Q.

(14) Ninety-three members were elected to fellowship, distributed among the sections as follows:—

Section A, 2; Section B, 23; Section C, 5; Section D, 21; Section E, 1; Section F, 3; Section G, 4; Section H, 2; Section I, 1; Section K, 13; Section O, 14; Section M, 2; Section N, 2.

(15) On reference by the council, the executive committee adopted the following amendment to the by-laws, to replace Section 4, of Art. II:

Article II, Section 4.—Members may be elected by the council to be fellows of the association and members so elected shall remain fellows only so long as they retain membership. If a fellow discontinues his membership and subsequently rejoins the association he shall automatically again become a fellow from the time of rejoining, without another election. Members are eligible to nomination for fellowship if they have contributed to the advancement of science either by the publication of original research or in other significant manner. Nominations for election to fellowship may be made by any three fellows, by the permanent secretary or by any section secretary, but before being submitted to the Council every nomination shall have been first approved by the section committee in whose field the nominee's scientific work mainly lies.

Explanatory note.—It is understood that members are eligible to fellowship nomination if their names occur in the most recent edition of "American Men of Science" or if they have been elected to an affiliated organization in a membership class for which a research qualification is required. It is understood that the phrase, "the publication of original research," implies more than the publication of a dissertation for the Ph.D. degree, and that it is the intention to admit members to fellowship on the basis of publication only after they have shown more evidence of productiveness than the attainment of the Ph.D. degree. The phrase, "or in other significant manner," is taken to include advanced teaching and the guiding of research, also suitable patents and the accomplishment of work not shown by publication, as in engineering or other projects in the fields of applied science. A majority of those voting shall constitute approval of a nomination by a section committee.

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[1] Summarized Proceedings of the American Association for the Advancement of Science, 1921–1925, page 66.

(The amendment and its explanatory note differ from the old *Section 4 of Art. II in the following ways:* (1) The rule about automatic reelection to fellowship upon rejoining the association is new. (2) The wording of the definition of eligibility is improved, but the meaning is not altered. (3) Nomination by three fellows is new; nomination by the nominee himself is now discontinued, also nomination by any member. (4) The old by-law did not specify preliminary approval by the section committee concerned, but that specification was made by special vote of the council and has been presumably in effect for a number of years, though it may not have been adhered to in all cases when a section secretary has transmitted nominations to the council.)

(16) On recommendation of the executive committee the council voted that members residing outside of the United States shall no longer be required to pay the extra postage on their journals.

(17) The council adopted the following resolution on the Michael P. Rich Bequest:

WHEREAS, The late Doctor Michael P. Rich, of New York City, with a generous purpose to provide some part of the means needed for organizing American scientific men in the interest of development and progress and with a vision of the fundamental relation of this movement to the future of America, provided in his last will and testament that the association should receive from his estate a bequest of ten thousand dollars ($10,000) to be added and to become a part of the endowment fund; therefore, be it

Resolved, That the council in this way acknowledges publicly and for permanent record and in behalf of the scientific workers of America its deep appreciation of the gift and the spirit which animated it. Further, be it

Resolved, That the council speaking for the association orders that this part of the association's permanent endowment be named The Michael P. Rich Fund, and be so carried on the records of the treasurer; the income of which is to be utilized for the advancement of science and education as the best judgment of the association shall determine in accordance with the development of America and the changing conditions of its work.

Therefore, The council directs that copies of these resolutions be spread upon its records, printed in its publications and transmitted to the executors of the estate and to relatives of the late Doctor Michael P. Rich.

(18) In connection with information given to the council by Dr. F. R. Moulton concerning the Chicago Exposition of 1933 and upon recommendation of the executive committee, the council voted that the time of the next Chicago meeting be changed from December, 1932, to the summer of 1933, preferably the first week of September, and the council adopted the following resolution expressing the willingness of the American Association to cooperate with other organizations in connection with the International Science Congress that is being planned as a feature of the 1933 exposition at Chicago.

A Resolution Concerning the Relation of the American Association to the Chicago Exposition to be Held in 1933

WHEREAS, The American Association for the Advancement of Science has learned that an international science congress is being considered as a feature of the great Chicago Exposition in 1933, and

WHEREAS, The association regards it as highly desirable that an international congress or a series of international congresses be held in connection with the above-mentioned exposition; be it therefore

Resolved, That the American Association for the Advancement of Science, which represents over 18,000 members, mostly residing in the United States, and 120 associated scientific organizations, will be glad to cooperate with other scientific associations and societies and with the management of the exposition in connection with arrangements for the proposed international congress to emphasize the important place of science in a century of progress.

(19) The council approved a tentative schedule of future meetings, including summer meetings, which appears elsewhere in this issue of SCIENCE.

(20) A special committee, consisting of Robert A. Millikan and Walter S. Adams, was named to investigate the possibilities in regard to the proposed summer meeting in the Los Angeles region in 1931.

(21) The council adopted the following resolution on the Copeland-Wainwright Bill, now before the Congress of the United States.

WHEREAS, Those who are interested in the advancement of science appreciate the very great service done to science and humanity by the heroic sacrifices of Major Walter Reed, Major James Carroll and Doctor Jesse W. Lazear, in connection with the early experimental study of yellow fever, which has subsequently led to the control of this disease largely as a result of their heroism; be it therefore

Resolved, That the American Association for the Advancement of Science favors and strongly urges the passage of the Copeland-Wainwright Bill now before the United States Congress, in so far as that bill provides suitable annual pensions for the widows of the above-mentioned men, and be it further

Resolved, That the American Association greatly appreciates the well-directed efforts of Congressmen Copeland and Wainwright and their supporters, toward the passage of the Copeland-Wainwright Bill.

(22) The council adopted the following resolution on the maintenance of the National Parks System of the United States:

In view of the present discussion of the National Parks System and of numerous proposals for its extension, the American Association for the Advancement of Science, with its 19,000 members and 120 associated organizations, desires to reaffirm its position taken after careful study of the problem and expressed in a resolution adopted in December, 1927, as follows:

(1) The association approves the creation of those national parks only which meet the highest standards of the system, namely, which are wholly or almost wholly areas of original, unmodified natural conditions, each a unique example of its landscape or geologic type in the country; and

(2) The association declares that, as the only reservational system for preservation of the primitive and majestic in nature, the protection inviolate of the system of national parks demands extraordinary watchfulness and care; and

(3) The association recognizes that, by reason of its peculiar limitations and conditions, the system of national parks possesses facilities for popular education in nature and for inspiration, which have incalculable value to individuals and the nation.

And the association directs that the permanent secretary of the American Association for the Advancement of Science shall send copies of this resolution to President Hoover, to the Secretary of the Interior, to the Secretary of Agriculture and to the secretaries, chairmen and members of the Public Lands and other committees of both houses of Congress having this matter in charge.

(23) The council commended the efforts of the Conservation Committee of the Camp Fire Club of America toward the maintenance of the present high standards of the National Parks System of the United States, and referred, for a statement of the position of the association in this connection, to the resolution adopted by the council at Nashville, December 28, 1927, and to the resolution on the same subject adopted by the council December 31, 1929 (see item 22, above).

(24) The council adopted the following resolution on the control of the Mediterranean fruit fly.

Whereas, The American Association for the Advancement of Science recognizes that the presence of the Mediterranean fruit fly in Florida is a serious menace to the horticultural and agricultural interests of the southern and western states, and that its permanent establishment in that region would materially affect the interests of the consuming public of the entire nation; therefore, be it

Resolved, That this association wishes to express its appreciation of the vigorous and effective manner in which the program of control has been carried out and urges that every feasible measure, most of all scientific investigation of the causes and effects of this pest, be taken that will lead to its control and ultimate suppression.

(25) The council elected the association president for 1930 and other officers, as shown elsewhere in this issue of Science.

(26) Just before adjournment the council adopted the following resolutions of thanks:

(A) The council wishes to express to President Millikan its great appreciation of the efficient manner in which he has occupied the presidency, and thanks him especially for the efficiency and geniality with which he has presided at the sessions of the council and other sessions at Des Moines.

(B) The council expresses its gratitude to Dr. D. W. Morehouse, general chairman of the local committees of the Des Moines meeting, for the highly efficient service he has rendered to the association and requests him to transmit its hearty thanks to the chairmen of the several special committees on arrangements, through whose cordial cooperation this meeting was made so successful.

(C) The council thanks the Iowa Academy of Science, Drake University, the School Board of Des Moines, the Des Moines Club, the Women's Club and the people of Des Moines and Iowa for their hospitality and their interest in the work of the association.

(D) The council expresses its appreciative thanks to the newspapers of Des Moines, to the representatives of Science Service, the Associated Press and the United Press and to the other press representatives who cooperated so efficiently, both before and during the period of the meeting, with the Press Service of the American Association in its efforts to disseminate the science news of the meeting as widely as possible.

(27) The next regular session of the executive committee is to occur in Washington on Sunday, April 27, 1930. The next regular session of the council is to occur at Cleveland on Monday, December 29, 1930.

THE PRESIDENT ELECT

At the council session Tuesday morning, December 31, 1929, Dr. Thomas Hunt Morgan, director of the Kerckhoff Laboratories of the Biological Sciences, of the California Institute of Technology, was unanimously elected president of the American Association for the Advancement of Science for the year 1930. Professor Morgan was born in Lexington, Kentucky, and is a graduate of the University of Kentucky. He received the Ph.D. degree at the Johns Hopkins University in 1890 and spent the following year there as Bruce fellow. For the next thirteen years he was professor of biology in Bryn Mawr College. In 1904 he was called to Columbia University as professor of experimental zoology, where he remained till last year. His call to the California Institute of Technology resulted in the transfer of one of our most eminent zoologists from the Atlantic to the Pacific Coast. He is the third member of that comparatively young California institution to be elected to the presidency of the American Association. The California Institute may be legitimately proud of its three association presidents: Arthur A. Noyes, Robert A. Millikan and Thomas H. Morgan. Dr. Morgan is now president of the National Academy of Sciences. He has received a number of honorary degrees and holds membership in many learned societies. His membership in the American Association dates from 1904, and he has been a fellow of the association since 1906.

The literature of experimental zoology and genetics contains many valuable contributions by Morgan and his students. He is the author of many well-known books, among which are the following titles:

"Regeneration," 1901.
"Evolution and Adaptation," 1903.
"Experimental Zoology," 1907.
"Heredity and Sex," 1913.

"The Mechanism of Mendelian Heredity" (with A. H. Sturtevant, H. J. Muller and C. B. Bridges), 1915 (rev. edit., 1922).
"A Critique of the Theory of Evolution," 1916.
"Sex-Linked Inheritance in Drosophila," 1916.
"The Physical Basis of Heredity," 1919.
"The Genetic and the Operative Evidence Relating to Secondary Sexual Characters," 1919.
"The Origin of Gynandromorphs," 1919.
"Human Inheritance," 1924.
"Evolution and Genetics," 1925.
"The Theory of the Gene," 1926.
"Experimental Embryology," 1927.
"What is Darwinism?," 1929.

The newly elected president's many successful researches are familiar to all biologists. They have been concerned largely with the physical basis of heredity, with the physiological aspect of inheritance. With Morgan's leadership and under the influence of his masterly reasoning and adequately planned experimentation the hypothesis of the germ plasm as the bearer of hereditary characters has become progressively clearer in the last quarter century, many able minds having taken part. From vague and merely hypothetical beginnings at the hands of Weissmann and others this theory has become the modern theory of the gene, the best account of which is Morgan's recently published book of that title. That genes are very small particles or aggregates of matter that are transmitted from parent to offspring, fundamentally influencing the development and the characteristics of organisms, is now generally held by students of genetics. To explain the origin of new forms of animals and plants it is supposed that new combinations of genes are continually arising and that a particular kind of gene may occasionally become fundamentally altered, under suitable conditions. The physical nature of genes and how they may become transformed so as to exert new influences, thus taking part in the origin of new forms of organisms, are topics of great present interest, in the consideration of which the findings of cytology and cell physiology are being studied in the light of our rapidly growing chemical and physical knowledge, notably in the field of colloid chemistry. Morgan points out[1] that changes in genes are to be considered as possibly occurring either in the direction of greater complexity or in the opposite direction; to begin to understand the nature of supposed gene changes we shall need to know "more concerning the chemical constitution of the genes and how they grow and divide." In a similarly clear manner Morgan goes on to call attention to the present futility of attempting to discuss whether or not genes may arise *de novo* or how they may have come originally into existence. He regards it as at least possible that genes may have the nature of organic molecules, but emphasizes the fact that evidence for such a supposition is inadequate at present; they may be aggregates of molecules. He finds it difficult, however (*loc. cit.*, p. 310), "to resist the fascinating assumption that the gene is constant because it represents an organic chemical entity." He considers that "this is the *simplest assumption that one can make at present*," and that "since this view is consistent with all that is known about the stability of the gene it seems, at least, a good working hypothesis."—B. E. L.

THE FINANCIAL CONDITION OF THE ASSOCIATION

The audited report of the association treasurer for the fiscal year closing September 30, 1929, and the audited financial report of the permanent secretary for the same year were accepted and approved by the council at Des Moines. These reports are on file in the Washington office of the association and copies may be secured on request. The following summary notes on them have been prepared by the permanent secretary.

Note on the Treasurer's Report for the Fiscal Year 1928–29. The total amount of the endowment fund of the association was $159,776.66 on September 30, 1929. This consisted of the Richard T. Colburn fund ($85,586.45), the W. Hudson Stevens fund ($4,381.21), the Michael P. Rich fund ($10,000.00), the Jane M. Smith fund ($5,000.00), the accumulated contributions from friends of the association ($3,559.00), the fees of sustaining members ($7,000.00) and the fees of life members ($44,250.00). On the same date the amount of available treasury funds (unexpended income from the endowment and special reserves) was $19,520.07, consisting of unexpended reserves ($13,727.23), the undisbursed balance of the 1928–29 appropriation for the Committee of One Hundred on Research ($792.84) and the prize fund ($5,000.00). On October 1, 1929, the balance on account of the Committee of One Hundred reverted, to be added to the unexpended reserves, which then amounted to $14,520.07. Liabilities for 1930 against this available fund were $1,388.00, consisting of the annual rental to be paid for the treasurer's safe-deposit box ($20.00) and journal subscriptions to be paid for life and sustaining members for 1930 ($1,368.00). The unappropriated and undesignated balance of the treasurer's available funds was therefore $13,132.07 on October 1.

Since the last-mentioned date appropriations from the treasurer's available funds have been made amounting to $4,300.00, consisting of appropriations for the Committee of One Hundred on Research for 1929–30 ($1,000.00), for allotment by the Committee on Grants for Research for 1930 ($3,000) and for three emeritus life memberships ($300), leaving a balance of appropriable funds amounting to $8,832.07. Of this amount $6,723.48 had been accumulated before the fiscal year 1928–29 and is considered as a treasurer's emergency fund. Without decreasing this emergency fund the executive committee may make further appropriations for the current fiscal year amounting to $2,108.59. The principal of the prize fund is held in trust for the annual prizes of $1,000 each. Since October 1 that fund has been increased by a further gift of $1,000 from the original donor and it has been decreased in the same amount by the award of the Des Moines prize. The treasurer, therefore, now holds $5,000 in the prize fund, definitely designated for five annual prizes of $1,000 each, the first of which is to be awarded at the Cleveland meeting next December.

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[1] "The Theory of the Gene," 1926, p. 308.

Note on the Permanent Secretary's Financial Report for the Fiscal Year 1928–29.—A summary of the permanent secretary's financial report of September 30, 1929, follows:

	Forwarded from last report	Receipts, 1928–29	Disbursements, 1928–29	Balance, Sept. 30, 1929
Emergency fund	$5,000.00			$5,000.00
Publication fund (for Proceedings volume)	3,000.00	$11,340.50	$ 1,703.53	12,636.97
Meeting fund		5,753.41		5,753.41
Committee on Place of Science in Education	427.00		9.52	417.48
Joint Committee on Research in Colleges	90.58	50.00	106.11	34.47
Miscellaneous Liabilities	1,684.74	1,771.77	1,684.74	1,771.77
Generally available	5,219.61	126,114.96	124,090.48	7,244.09
Total	15,421.93	145,030.64	127,594.38	32,858.19

By act of the council, the permanent secretary's emergency fund is maintained at $5,000 from year to year. On December 20, after all expenses of the Proceedings volume for 1925–29 (published October 15, 1929) had been paid, and after $1,000 had been added to the publication fund from the receipts of 1929–30, the balance of the publication fund was $4,536.50. Of this, $4,000 is reserved for the next Proceedings volume and the remainder is now transferred to the generally available fund. The meeting fund is a new one, derived from the fifth New York meeting. It is reserved for deficits that may accrue from meetings with incomes less than their costs, being therefore an emergency fund for meetings.

THE DES MOINES SESSION OF THE SECRETARIES' CONFERENCE

(*Report from Harley J. Van Cleave*)

The Des Moines session of the secretaries' conference was held on Sunday afternoon and evening, December 29, with Philip Fox in the chair. Special attention was given to a discussion of the relationship between the sections of the association and the related professional societies. Coordination of programs and the possibility of scheduling joint sessions and society dinners through the agency of this conference, to avoid conflicts of allied interests, were discussed. Members of the secretaries' conference dined together, at the annual secretaries' dinner, provided by the American Association. Following the dinner, Dr. Livingston explained in detail the new by-law relating to nominations to fellowship in the association and presented an account of the new procedure to be followed by section secretaries and their section committees in making up annual lists of fellowship nominations for action by the council. The secretary of the secretaries' conference for 1930 is Harley J. Van Cleave, secretary of the American Microscopical Society. The chairman for 1930 is Philip Fox, secretary of Section D (Astronomy).

THE DES MOINES SESSION OF THE ACADEMY CONFERENCE

(*Report from A. C. Walton*)

The Academy Conference acts as a standing committee of the American Association, to facilitate the work of the affiliated academies of science and to further cooperation among them and between them and the association. Its membership consists of the council representatives of the affiliated academies (one from each academy) and three members named by the council to represent the association at large. The conference secretary carries on a correspondence with its members throughout the year and an annual session, with a complimentary dinner provided by the association, is held at each annual association meeting.

The Des Moines session of the Academy Conference was held Friday afternoon, beginning at 4:30, with Howard E. Enders in the chair. D. W. Morehouse, secretary of the conference for 1929, automatically became chairman for 1930 and Chancey Juday, of the Wisconsin Academy, was elected secretary for

1930. In the absence of Dr. Juday, A. C. Walton, of the Illinois Academy, was appointed secretary *pro tem.* A vote of thanks and appreciation was extended to Dr. Enders, for his activity in the early days of the Academy Conference; he was the first secretary and did much to get the organization started.

Mr. Louis Astell, of the West Chicago High School, an invited guest of the conference, read a suggestive, informing and stimulating paper on "How State Academies May Aid Science Study among High-school Students." Mr. Astell told of the successful organization and operation of science clubs in Illinois high schools. It is planned that this paper will soon be published, with the help of the Committee on the Place of Science in Education, of which Otis W. Caldwell, of Columbia University, is chairman. Dr. Caldwell, who was present at the session as an invited guest, spoke in the discussion following Mr. Astell's paper. A. C. Walton, secretary of the Illinois Academy, and Lyell J. Thomas, also of the Illinois Academy and an invited guest at the session, spoke on the very successful campaign that is being carried out among the Illinois high schools. It seemed clear that state academies may do a great deal for the advancement of science by leading or aiding in organized effort to find and encourage exceptional high-school students who have a bent for and an interest in science study. The new project of the American Association's Committee on the Place of Science in Education, authorized by the association council at Des Moines, is planned as a nation-wide move in that direction and the committee with that project in charge would welcome the cooperation of state academies.

The session closed with the annual academy dinner, given by the American Association to the members of the conference. At the dinner the following resolution, proposed by John T. McGill, of the Tennessee Academy, was unanimously adopted.

> Whereas, The interchange of their publications by the affiliated state academies would be advantageous in promoting closer relationship with one another and in disseminating information about their special activities; therefore, be it
>
> *Resolved,* That each academy is requested to send to the other academies copies of its current publications and of back numbers as far as feasible.

A unanimous vote of appreciation was extended to Dr. Livingston and through him to the American Association for the success of the Academy Conference and also for the courtesy of the academy dinner.

FUTURE MEETINGS

It was voted by the association council at Des Moines to inaugurate a new plan by which the American Association is to hold two meetings a year instead of the single annual meeting. Winter meetings are to be continued as heretofore, and in addition a summer meeting is to be held each year, either at the beginning or at the end of the summer. The first of the summer meetings is scheduled for the summer of 1931, probably in the region of Los Angeles. The Pacific Division and the Southwestern Division will hold meetings as usual in 1930, that of the Pacific Division being at Eugene, Oregon, from June 18 to 21, while that of the Southwestern Division will occur at Tucson, from April 21 to 24.

The schedule of future meetings of the association, as far as it has been made out, is shown below:

December, 1930, Cleveland (Monday, December 29, 1930, to Saturday, January 3, 1931).
Summer, 1931, probably Los Angeles region.
December, 1931, probably New Orleans (Monday, December 28, 1931, to Saturday, January 2, 1932).
Summer, 1932, probably Montreal.
December, 1932, probably New Haven (Monday, December 26, to Saturday, December 31, 1932).
Summer, 1933, Chicago.
December, 1933, undecided (Wednesday, December 27, 1933, to Tuesday, January 2, 1934).
Summer, 1934, probably San Francisco.
December, 1934, probably Rochester, N. Y. (Thursday, December 27, 1934, to Wednesday, January 2, 1935).
Summer, 1935, probably Minneapolis.
December, 1935, undecided (Friday, December 27, 1935, to Thursday, January 2, 1936).
Summer, 1936, undecided.
December, 1936, Washington, D. C. (Monday, December 28, 1936, to Saturday, January 2, 1937).

It is to be noted specially that the large meeting that would regularly occur at Chicago in December, 1932, has been changed to the summer of 1933. This change was due to the decision of the American Association to cooperate in every possible way with the plans and arrangements for the "Century of Progress" exposition, which is to be held at Chicago in the summer of 1933, with science as its keynote and a great international congress of science as an important feature. The exact dates of the proposed summer meetings are still to be fixed. The dates for the winter meetings are determined by a general rule of the council, according to the week day on which New Year's day falls.

It is hoped that many societies will plan to meet with the association at the summer meetings. The scientific societies are always invited to meet with the larger organization at its winter meetings, if they so desire, and the same invitation will hold for the summer meetings.

THE SCIENTIFIC SESSIONS AT DES MOINES

The following accounts of the sessions of the sections and societies that took part in the Des Moines meeting have been prepared from reports received from the several secretaries, as indicated. They are arranged according to the association sections. It will be noted that several societies are shown as related to both the zoological and botanical sections and that another group is shown as related to the association as a whole.

SECTION A (MATHEMATICS) AND RELATED ORGANIZATIONS

(*Report from C. N. Moore*)

Section A held a joint session on Monday afternoon with the American Mathematical Society. R. C. Archibald gave the retiring vice-presidential address, on "Mathematics before the Greeks," which was published in SCIENCE for January 31. O. D. Kellogg delivered an invitation address on "An Unsolved Problem of Uniqueness in Potential Theory," which dealt with the well-known Dirichlet problem and a number of related theorems. The seventh Josiah Willard Gibbs lecture was given by Irving Fisher, of Yale University, at a general session on Tuesday afternoon. The title of the address was "The Application of Mathematics to the Social Sciences." It began with a tribute to Gibbs as a great scientific genius and a personal appreciation of him as a most inspiring and stimulating teacher. It was then pointed out that Gibbs's work in vector analysis had proved useful not only in physics and mathematics but also in economics. The address mainly dealt with the four different branches of social science to which mathematics has been or may be applied: (1) pure theory, (2) fitting of formulas to statistics, (3) correlation and (4) probabilities. The lecturer expressed the opinion that there would be an ever-increasing use of mathematical methods in the field of social science. Professor Fisher's address will appear in the *Bulletin of the American Mathematical Society*. At a joint session of the American Mathematical Society and the Mathematical Association of America L. L. Dines gave an invitation address on "Linear Inequalities and some Related Properties of Functions," in which he outlined a theory of systems of linear algebraic inequalities analogous to the classical theory of systems of linear equations. The theory was then generalized so as to comprehend inequalities of nonalgebraic character, and in particular linear inequalities in infinitely many unknowns, and linear integral inequalities. This paper will be published in the *Bulletin of the American Mathematical Society*.

On Tuesday morning was held a joint session of Sections A and K and the American Mathematical Society, at which were presented papers dealing with mathematical methods used in the social sciences. The principal paper was an invited address by Henry Schultz, on "The Standard Error of a Forecast from a Curve." The American Mathematical Society held a general session on Monday morning, followed by two sectional sessions devoted to "Algebra and Number Theory" and to "Applied Mathematics." It held two sectional sessions on Tuesday morning, devoted to "Analysis" and to "Geometry."

The Mathematical Association of America held sessions on Wednesday morning and afternoon, in addition to the joint meeting Tuesday afternoon with the American Mathematical Society. R. P. Baker spoke on the geometric representation of groups, illustrating his remarks by numerous slides of the appropriate geometric configurations. M. H. Ingraham discussed the structure of algebras of infinite order and especially the application of the theory of transfinite numbers and well-ordered sets to this problem. J. W. Young gave an outline of the contents of his forthcoming Carus Monograph on Projective Geometry. On Wednesday afternoon E. B. Lytle discussed the manner in which appreciation of form could be used as an index of mathematical ability. W. H. Roever showed how the laws of rolling motion might be utilized in the construction of roller bearings with sliding friction completely eliminated and Warren Weaver showed how mathematical methods might be used in dealing with problems of ore location.

The Chauvenet prize, of $100, was awarded to T. H. Hildebrandt, of the University of Michigan, for his paper on "The Borel Theorem and its Generalizations" (*Bulletin of the American Mathematical Society* for 1926). This prize is awarded every three or four years for the best expository paper published in English by a member of the Mathematical Association in each three or four year term prior to the year of the award.

A joint dinner for mathematicians was held Tuesday evening, at which W. H. Bussey, of the University of Minnesota, acted as toastmaster. E. R. Hedrick, president of the American Mathematical Society, and J. W. Young, president of the Mathematical Association of America, spoke on important features of the activities of their respective societies, and several other speakers discussed pertinent topics.

SECTION B (PHYSICS) AND RELATED ORGANIZATIONS

(*Reports from A. L. Hughes and Charles F. Brooks*)

Section B met with its affiliated societies, the program being mainly in charge of the officers of the societies. The program for Tuesday afternoon was arranged by Section B. The first address was that of the retiring vice-president for the section, P. W. Bridgman, of Harvard University, on "Permanent

Elements in the Flux of Present Day Physics." Professor Bridgman opened with a short review of the astonishing advances made in physics within the last two or three decades, emphasizing the significant changes in our outlook on the physical world which have been necessitated by the work of Einstein, Bohr, Heisenberg, Jordan, Dirac and Weyl. Then came a discussion of what constitutes an adequate theory in physics. At one time it was considered necessary to attempt to explain all physical phenomena in terms of mechanical models, but this has been largely replaced and physicists are now generally content merely to describe and correlate the phenomena considered, using mathematical equations as the most concise way of effecting the description. The extraordinary success of the wave mechanics in interpreting results has led some to think that perhaps a real finality in our view of the physical world has at last been attained. But this is unlikely; many puzzles still remain unsolved, and their solution may call for further far-reaching changes in the theory. While it may be impossible for the majority of physicists to take time to master the mathematical technique of the new wave mechanics, yet Professor Bridgman thinks that every physicist should be sufficiently familiar with the fundamental concepts of this theory to enable him to think out problems in terms of these concepts, at least in a qualitative manner. The details of most of the mathematical developments are probably transient and need not be deeply studied by non-specialists, but certain broad fundamental principles probably transcend the mathematics by which they have been discovered.

The vice-presidential address was followed by two invitation addresses, one by A. Landé, of the University of Tübingen, and the other by L. H. Thomas, of the University of Cambridge. Professor Landé discussed "Polarization of Matter Waves." He pointed out that a Stern Gerlach apparatus with a screen having a suitable aperture is a polarizer for atoms, just as a Nicol prism is for light. But, while two Nicol prisms are "crossed" when they differ in orientation by 90°, two Stern Gerlach units have to differ in orientation with respect to each other by 180° to be "crossed" (*i.e.*, to refuse transmission to the matter beam passed by the first unit). Elliptically polarized matter beams can be formed out of linearly polarized beams by an intermediate transverse magnetic field between the two Stern Gerlach units. Rotation of the plane of polarization of matter beams can be effected by a longitudinal magnetic field between the two Stern Gerlach units. The analogy with optics is complete if the correspondence between the angles already mentioned is taken care of. The simple picture of quantization of direction in space fails in many cases and must be replaced by the methods of wave mechanics.

Dr. Thomas spoke on "The Wave Mechanics of Collision Processes." While there is considerable difference of opinion as to the meaning of the wave-mechanics, this does not extend to the methods of using it in practice. In the simplest possible case, the free motion of a single particle, solutions of the wave equation are built up out of error functions; mathematically these are most convenient and they are immediately seen to express exactly the Heisenberg uncertainty relation. When the wave equation for two particles that may collide is considered the solution takes a form recognized as expressing just what would be expected from a particle theory of the collision combined with the Heisenberg uncertainty; this requires essentially a wave-function which has a value for any possible position of the first particle combined with any possible position of the second. Finally, although it starts with an extended wave, an approximate solution of the wave-equation for a simplified picture of α-particles passing through a gas represents just that appearance of tracks seen in experiments and regarded as characteristic of a particle theory. It appears that the wave-picture can be extended right up to actual observation and, if the wave formulation is ultimate, it seems that we can, almost that we must, as C. G. Darwin expresses it, "put the inexplicable feature of the quantum theory, the irreconcilability of wave and particle, in exactly the place where we have got in any case to have an inexplicability in the transfer from objective to subjective." It may be that, given electrons, protons and the general nature of space and time (that is, given the form of the wave equation), all that remains of our knowledge may be expressed by the equation; but there still remains the form of the wave equation itself and we may have to go deeper to describe this.

Since there were but thirty-one contributed papers the American Physical Society completed its program in three sessions, Monday morning and afternoon and Tuesday morning. On Tuesday morning, the president of the society, H. G. Gale, of the University of Chicago, gave his presidential address, on "The Interplay of Theory and Experiment in Modern Spectroscopy." Balmer discovered in 1885 an empirical law connecting the frequencies of certain lines in the spectrum of atomic hydrogen. In 1913, Bohr, starting from the new quantum theory, not only accounted for these lines, but predicted other groups of lines, whose existence was soon confirmed by experiment. At the same time the confusion between the identity of the lines of ionized helium and those of atomic hydrogen was cleared up. A slight discrepancy found between the wave lengths of certain lines in the spectra of ionized helium and of hydrogen was completely explained by Bohr in terms of the finite mass of the nucleus, but the lines in the hydrogen spectrum were known to have a fine structure which was not taken care of by the simple Bohr theory and Sommerfeld combined relativity change of mass with the idea of elliptical orbits, and was able to give a satisfactory description of the fine structure. The intensity relations in the fine structure were not correctly given by the Sommerfeld theory, however, and Landé introduced a third quantum number "*j*," which was very useful in the theory of the Zeeman effect. The introduction of a quantum number for the spin of an electron by Uhlenbeck and Goudsmit, together with the other quantum numbers, led to a satisfactory theory of multiplets. But, while the first two quantum numbers used by Bohr could be correlated in a straightforward manner with the dimensions of the orbits, no such clean-cut correlation could be made for the additional quantum numbers. Although many interesting relations could be described empirically in terms of these quantum numbers, the state of affairs was unsatisfactory and paved the way for the introduction of wave mechanics. Just as Balmer was the first to find an empirical relation for a certain atomic spectrum, so Deslandres is to be regarded as the first to attack band spectra successfully. Because of the presence of two outer, loosely bound electrons in molecular hydrogen, helium and lithium, there are parallelisms between the spectra of these molecules and the spectrum of atomic helium. The history of the discovery of two kinds of hydrogen, *viz.*, para-hydrogen and ortho-hydrogen, was traced. Lastly, the new field of nuclear spin was mentioned, together with the most promising ways of disclosing it experimentally.

The tenth birthday of the American Meteorological Society was fittingly celebrated by the biggest meeting the society has held, thanks to the mid-west meteorologists, headed by Charles D. Reed. Four sessions, with long and lively discussions, were attended by from forty to over sixty persons. With mid-west interest in meteorology revolving chiefly around the climate of this great agricultural region and the rapid strides being made in aeronautics, this meeting was occupied very largely with climatological and aeronautical work. Officials of the U. S. Weather Bureau's climatological service in Illinois, Wisconsin, Iowa, South Dakota, Nebraska and Kansas spoke of the work of the large and earnest corps of cooperative observers. These observers were represented on the program by H. P. Lasher, with "Observations Regarding the Effects of Air Pressure upon Animal Life," and H. W. Kerr, speaking on "Amateur Radio in Emergencies." Discussion was very active. The history of climatological work in the United States was discussed: G. K. Greening, "Climatic Conditions in the Louisiana Purchase as Found by Lewis and Clark"; Clarence J. Root, "The Meteorological Service One Hundred Years Ago," and Eric R. Miller, "New Light on the Beginnings of the Weather Bureau from the Papers of Increase A. Lapham."

President W. J. Humphreys' second presidential address, on "The Structure of the Atmosphere," provided an appropriate setting for a group of papers on airways weather work. Wesley L. Smith brought out the great importance of meteorology from the operations standpoint and F. H. Week described a busy day at the Chicago airport. V. E. Jakl and W. C. Devereaux emphasized the hindrance imposed by fog and low clouds on aviation, and George Yates indicated the limits placed by weather on aerial photography.

Scientific long-range weather forecasting received a boost by Thomas A. Blair, in a paper on "Summer and Autumn Pressure Anomalies Affecting Winter Temperatures in the Upper Mississippi Valley." Characteristic distributions of pressure over the northern hemisphere were found to precede cold or warm winters in the upper Mississippi Valley. Mr. Blair and others were of the opinion that only through the use of northern hemisphere pressure departure maps (covering three months at a time) could a forecaster get such a picture of each year's situation as to enable him to forecast winter temperature for our interior.

John Patterson, director of the Meteorological Service of Canada, was elected president of the society for 1930 and 1931, and Edward Hall Howie, of the U. S. Weather Bureau, San Francisco, was elected vice-president for 1930 and 1931. Charles F. Brooks and Willis Ray Gregg were reelected secretary and treasurer, respectively, for 1930. H. Helm Clayton, Andrew E. Douglass, W. I. Milham, F. W. Reichelderfer and B. M. Varney were elected councilors for 1930–32.

SECTION C (CHEMISTRY)

(*Report from J. A. Wilkinson and W. F. Coover*)

All the sessions of Section C were held jointly with the Midwest Regional Group of the American Chemical Society, the Ames Section of the latter acting in the capacity of host. The Friday afternoon session, held in Des Moines, was devoted to a symposium on "Teaching General Chemistry." Neil Gordon, of Johns Hopkins University, editor of the *Journal of Chemical Education,* led the discussion and among the other speakers were teachers from high schools, junior colleges, liberal arts colleges, agricultural colleges and universities. R. A. Worstell, of Ft. Madison, and Neil Lutes, of Dubuque, outlined the problems and difficulties of teaching chemistry in the high school, and L. L. Minor, of Mason City, discussed the problems for the junior college. James E. Webster, of Oklahoma A. and M. College, reported the results of a questionnaire concerning the content of chemistry courses given at different schools to students in agriculture. Dr. Gordon emphasized the possibilities of talking motion pictures to supplement other methods of instruction in general chemistry. The paper that developed the greatest amount of discussion was presented by Willis J. Bray, of Missouri Teachers College, Kirksville, who presented results of aptitude tests showing that the difficulty experienced by students in general chemistry is largely due to the inability of the students to *read rapidly* and *understandingly* the ordinary text-book.

On Saturday morning at Ames the address of C. E. Kenneth Mees, retiring vice-president for Section C, was delivered by Leslie G. S. Brooker, in the absence of Dr. Mees. It dealt with development of photographic sensitizing dyes of the cyanine series. Orland R. Sweeney discussed possibilities for chemical utilization of agricultural products, especially the manufacture of wood and paper substitutes from cornstalks. At luncheon Dr. Mary Rising, of the University of Chicago, addressed the women on the subject of the contributions of chemistry to medicine with special reference to narcotics, anesthetics and analgesics.

On Saturday afternoon there were two simultaneous sessions, one devoted to a symposium on the "Chemical Utilization of Agricultural Products" and the other to a series of contributions. W. E. Emley, of the U. S. Bureau of Standards, discussed the "Manufacture of Xylose." A small cooperative plant is now producing about fifty pounds of xylose daily, using cottonseed bran. O. M. Buswell outlined his researches on the industrial utilization of cornstalks for the production of gas by the sludge process. H. A. Webber told of successful "Studies on Cornstalk Cellulose." Henry Gilman's paper was on "Furfural and its Derivatives," reporting on the preparation from furfural of many compounds, such as food preservatives, perfumes, flavoring extracts, antiseptics, insecticides, fungicides, anti-knock compounds and sweet-tasting compounds. E. V. Collins presented a paper by himself and J. B. Davidson, on the "Collection of Agricultural Materials." Difficulties encountered in the harvesting of cornstalks and getting them ready for transportation were discussed. Machinery for this is still in the experimental stage.

SECTION D (ASTRONOMY)

(*Report from Philip Fox*)

Section D held three sessions of papers contributed by astronomers from the Mississippi Valley. In the absence of Harlow Shapley, chairman of Section D, the retiring vice-president, J. S. Plaskett, and D. W. Morehouse presided. Several papers dealt with solar activity, all indicating that the present maximum is very broad. Among such papers were the account by C. D. Higgs and F. E. Roach of the recent November–December, 1929, disturbances, of unusual magnitude; an account of solar observations from 1890 to 1929 by D. E. Hadden, and a new attempt to relate the cause of sun-spots to planetary perturbations, by W. A. Luby. There were two excellent papers on the eclipse of May 9, 1929, the first by W. A. Cogshall, with beautiful photographs of the corona, taken at Iloilo, P. I., the second by H. T. Stetson, who got interesting results at Alor Star in spite of unfavorable sky. But perhaps the most important of this group of papers was that of H. T. Stetson on "Solar Activity and Radio Transmission in 1929." The motion-picture camera is coming into use in astronomy, as was illustrated by Dr. Stetson's motion pictures showing the various stages of the eclipse of the sun, and by a film by Philip Fox, showing the rotation of Jupiter and the progress of the moon into the earth's shadow during the eclipse of November 27, 1928. Dr. Stetson caught the very interesting instant of the appearance of the diamond ring effect. C. C. Wylie, who has enlisted wide cooperation in the observation of meteors, gave a discussion of material gathered and also plans for future observations by photographic methods. E. B. Frost presented a note on the installation of the Hale spectrohelioscope, a new and important tool for solar investigation; and E. A. Fath, a note on remounting a telescope, in which he described the making of a pier from boiler plates, joints being welded with an acetylene torch.

There were three papers on stellar spectroscopy. First, a paper by Paul Bourgeois, of the Yerkes Observatory, on the system 61 Mu Orionis, a system similar to 13 Ceti, a visual binary of rapid period, of which one component is a spectroscopic binary. The perturbations capable of observation in the spectroscopic system add great interest. Second, observations of 7 Epsilon Aurigae, by O. Struve and C. T. Elvey. This star is interesting not only because it has the longest known period of the eclipsing binaries, but also on account of the beauty and unusual variations in the spectrum. The third spectroscopic paper, Dr. J. S. Plaskett's vice-presidential address, on "Motions of the B-Type Stars," was by far the most important paper of the program. An enormous number of observations (including the radial velocities of 815 stars), mainly accumulated at the Dominion Astrophysical Observatory, Ottawa, was given masterful and penetrating treatment, with results that point emphatically to the conclusion that our galaxy is in rotation about a distant center in the direction of longitude 327 degrees. This result makes our galaxy appear to be even more closely akin to the spiral nebulae than was supposed. It may be significant that the indicated direction of this motion coincides with that suggested by Dayton C. Miller's observations on ether drift. E. B. Frost's address on "Some Aspects of Celestial Evolution" was given at a general session of the association, as has been noted. This lecture dealt with the dramatic phenomenon of new stars and their bearing on theories of stellar and planetary evolution. A complimentary lecture to the public was given by Philip Fox on "The Adler Planetarium and Astronomical Museum of Chicago," which is to open about April 1, 1930.

An account of the astronomical features of the Des Moines meeting would be incomplete without mention of the visit to the Drake Municipal Observatory, which bears a dedication from the City of Des Moines to Professor D. W. Morehouse, president of Drake University, a rare college president, who, in addition to his many and exacting administrative duties, finds time to give a course in general astronomy and to direct the activities of this observatory.

SECTION E (GEOLOGY AND GEOGRAPHY)

(Report from Kirtley F. Mather)

Section E held four sessions on Monday and Tuesday. None of the organizations related to this section were in session in Des Moines, but about seventy-five geologists attended the meeting and thirty-eight papers were listed on the program. The address of the retiring vice-president, Frank Leverett, of the University of Michigan, was given Monday afternoon on "Problems of the Glacialist." Among other subjects, the causes of glacial climates were considered. Discussion centered chiefly about the papers by G. F. Kay and E. T. Apfel, "The Pre-Illinoian Pleistocene Geology of Iowa"; C. L. Baker, "Tectonics of the Eastern Mexico Cordillera and the Laramide Thrusts of Trans-Pecos Texas"; A. L. Lugn, "Ground Water Hydrology and Pleistocene Geology of the Platte River Valley and Adjacent Areas in Nebraska"; E. H. Barbour, "Proboscidea of Nebraska," and H. J. Cook, "Recent Discoveries concerning Ancient Man in North America." Other papers dealt with the stratigraphy and paleontology of various localities in the Mississippi Valley and with the physiographic development or glacial history of various portions of the northern states. On Monday afternoon a lecture complimentary to the public, on "Earthquakes and What They Tell Us," was delivered in the Shrine Temple auditorium by Dr. J. B. Macelwane, of St. Louis University. This lecture was illustrated in part by a motion-picture film on earthquakes recently produced by Pathé Exchange in cooperation with the department of geology of Harvard University. Monday evening a dinner for geologists and geographers was held in Younkers Tea Room, attended by approximately fifty guests. Tuesday evening George F. Kay, of the University of Iowa, vice-president of the American Association for Section E, delivered a lecture on "Glaciation: the Background of the Development of the Mississippi Valley," at a general session of the association.

SECTION F (ZOOLOGICAL SCIENCES) AND RELATED ORGANIZATIONS

(Reports from Geo. T. Hargitt, D. E. Minnich, J. J. Davis, T. H. Jones, Blanche Wheeler and Jesse M. Shaver)

Section F held no separate sessions at Des Moines and all contributed papers from its members appeared in the program of the American Society of Zoologists, which extended from Monday to Wednesday. The American Society of Zoologists held sessions for the reading of papers on Monday and Tuesday mornings. Fifty papers were read, exclusive of joint programs, distributed as follows: general and comparative physiology, 33; cytology, 7; embryology, 6, and miscellaneous, 4. The sessions were well attended, the attendance frequently running well over one hundred. The Monday afternoon program was given over to informal demonstrations, about twenty papers being presented in this manner. Most of the sessions were held in the library and annex of the Hotel Savery. The thanks of the two organizations are extended to the hotel management and to the local committee for their efficient preparations. Some of the sessions of the genetics section of the society were held at the Iowa State Agricultural College, in Ames. Joint sessions were held with the American Society of Parasitologists on Monday morning and with the Ecological Society of America on Tuesday morning. The annual biological smoker occurred Monday evening, a most enjoyable social gathering in the Scottish Rite Temple, whose fine building was opened for inspection and whose hospitality was generously extended. Several of the lectures at general sessions and several of the complimentary non-technical lectures were of a biological character and were enjoyed by many of the attending zoologists.

On Tuesday evening a dinner for all zoologists was held at the Hotel Savery (headquarters), attended by about two hundred, following which was delivered the address of the retiring vice-president of Section F, M. F. Guyer, of the University of Wisconsin. Speaking on "The Germinal Background of Somatic Acquirements," Professor Guyer discussed the relations of organisms to their surroundings, their adaptations, variations and modifications, and pointed out some of the possible correlations between these and the germinal constitution. The germ cells and genes are subject to the same influences as the body and have been shown in some cases to be directly influenced or modified by external forces. This paper is to be published in Science. On Wednesday morning a general session of all zoologists was devoted to the address of the retiring president of the American Society of Zoologists, C. B. Davenport, on the topic, "Light Thrown on Evolution by Genetics." Dr. Davenport discussed genes in relation to both individual development and evolution; both are related to the same internal causes and are conditioned by the environment; it is to the genes and their behavior that we go for an understanding of ontogeny and evolution.

The Entomological Society of America held its twenty-fourth annual meeting from Saturday to Monday, with thirty-one contributed papers. One afternoon was devoted to an invitational symposium on "Important Contributions which America has Made to the Study of Insects." The discussions on this subject included taxonomic contributions by C. E. Mickel, biological by D. M. DeLong, morphological by W. P. Hayes, physiological by E. F. Phillips, ecological by S. A. Graham and economic by Arthur Gibson. Much interest and discussion were aroused by this symposium. All papers on the program were exceedingly interesting in their special fields. Of general interest were the following: "The Food of Insects Viewed from the Biological and Human Standpoint," by the retiring president, C. T. Brues; "Analysis of Metamorphosis in Insects," by C. H. Kennedy; "Dragon-fly Collecting in China," by J. G. Needham; "The Biotic Constants of Insects," by R. N. Chapman, and "Entomology around the World," by T. D. A. Cockerell. The annual public address of the Entomological Society was given by William M. Mann, director of the National Zoological Park, at Washington, on "Economic Adventures of an Uneconomic Entomologist." Dr. Mann told of experiences in Lower California, Mexico and Central American countries. On Sunday there was an informal inspection of the entomological work of the Iowa State College, at Ames. The officers of the Entomological Society for 1930 are: *President*, Edith M. Patch; *vice-president*, R. E. Snodgrass; *second vice-president*, R. W. Doane; *secretary-treasurer*, J. J. Davis.

The American Association of Economic Entomologists held its forty-second annual meeting from Monday to Wednesday. At the meeting of the Section of Plant Quarantine and Inspection (F. N. Wallace, *chairman;* S. B. Fracker, *secretary*), Mr. Wallis discussed the training and temperament required for successful plant quarantine enforcement. The status and importance of the Mediterranean fruit-fly eradication campaign in Florida were described by L. A. Strong and Wilmon Newell. Other phases of federal quarantine activities and similar work in the various states were discussed by a number of speakers. Officers of the Quarantine Section for 1930 are: E. N. Cory, *chairman;* S. B. Fracker, *secretary.*—The Section of Extension (J. A. Hyslop, *chairman;* G. F. MacLeod, *secretary*) held a symposium of several short papers on cooperative work among extension entomologists.—The Section of Apiculture (G. M. Bentley, *chairman;* E. N. Cory, *secretary*) was addressed by the chairman and had a program consisting of ten papers, dealing with various phases of apiculture. R. L. Parker is chairman for 1930 and F. B. Paddock is secretary.

The general program of the Association of Economic Entomologists began on Tuesday morning, with the address of President T. J. Headlee, on "Some Tendencies in Modern Economic Entomological Research." This was followed by the reading of fifty-seven papers. Of these there were four papers on insects affecting forest and shade trees, eighteen on insects affecting deciduous fruits, thirteen on insects affecting cereal, forage and field crops, one on insects affecting animals, five on insects affecting truck crops, five on insects affecting the household and stored products and six on unclassified topics. Of the papers on insects affecting deciduous fruits, there were six on the codling-moth and five on the oriental fruit moth, various measures for the control of each pest being discussed. Papers relative to new pests of apple, cherry and raspberry were also presented. Papers on insects affecting cereal, forage and field crops dealt with the biology of the Hessian fly and the corn-borer, the pink bollworm, wireworms and certain insects attacking clover and alfalfa. Papers dealing with insects affecting truck crops had to do with the Mexican bean-beetle, the potato leaf-hopper and the onion maggot, while those relating to insects affecting the household and stored products covered the control of insect pests of upholstered furniture, storage of furs and other garments, the pea weevil problem and methods of protecting seed. Papers having to do with insecticides dealt with lead arsenate and sodium fluosilicate, arsenical substitutes, oil sprays and insect respiration in relation to the toxicity of contact insecticides. Other papers were presented on parasites, insect association studies and experimental plots.

On Sunday many of the members attending the meeting of the Association of Economic Entomologists visited the Iowa State College at Ames, where they learned much of the work of the departments of zoology and entomology and attended an entomologists' dinner. The speaker at the dinner was Herbert Osborn, of the Ohio State University, who discussed the early history of entomology in the central states. The regular entomologists' dinner was held at the Hotel Savery in Des Moines on Tuesday evening, and it was well attended and very much enjoyed. Franklin Sherman is president of the Association of Economic Entomologists for 1930, J. S. Houser is first vice-president and A. F. Burgess is secretary.

The American Society of Parasitologists held its sixth annual meeting from Saturday to Tuesday, with about seventy members present. The address of the retiring president, N. A. Cobb, on "Recent Aspects of Nematology," was of unusual interest. After showing a fine series of lantern slides to illustrate the recent advances in knowledge of the structure and biology of the free-living nematodes, Dr. Cobb pointed out in detail the inadequacy of the discussion given to this group in text-books of zoology. An important feature of the Des Moines program was a symposium on veterinary parasitology. E. R. Becker and J. A. Schulz reported some interesting experiments on the infusoria of the stomachs of ruminants, indicating that these protozoa were of no aid to the host in the digestion of food. M. C. Hall discussed in a very entertaining and stimulating way the training and point of view needed by a student on entering the field of veterinary parasitology, and F. C. Bishopp gave a review of the most important unsolved problems in the relation of insects to veterinary medicine. The symposium closed with a motion picture prepared by J. N. Shaw and B. T. Simms on the liver flukes of sheep, cattle and goats.

An unusually large number of interesting papers were contributed, a portion of which were presented wholly or in part by demonstrations. A. E. Woodhead presented by motion picture and lantern slides some of his recent studies on the larvae of Bucephalus. In papers on the germ-cell cycle of the digenetic trematodes F. C. Brooks reported that he was unable to find any indication of polar bodies in the sporocysts and rediae, and he presented a new theory of trematode development. H. E. Meleney presented a preliminary report on some community surveys for intestinal protozoa in Tennessee, which showed a very high incidence of the dysenteric ameba, *Endamoeba histolytica*. Besides those in the symposium and the address of the retiring president there were fifty-two papers on the program, of which twenty-one were read by title. Of the contributed papers sixteen were in protozoology, twenty-nine in helminthology and seven in entomology or general parasitology. These papers give a fairly good cross section of the research that is being done in the United States in parasitology. They show the present emphasis on experimental method and the part that practical problems of human or economic interest play in the field. The following officers of the Society of Parasitologists were elected for 1930: *President*, W. W. Cort; *vice-president*, E. C. Faust; *secretary-treasurer*, N. R. Stoll; *new council members*, Benjamin Schwartz and W. B. Herms.

The Wilson Ornithological Club held its sixteenth annual meeting on Friday and Saturday with 210 registered members and visitors present. Twenty-six papers covering a wide range of topics were presented and eight papers were read by title. The order of moulting of feathers in birds was traced by treating each feather tract separately, by Lynds Jones. L. H. Pammel showed interesting lists of flowers that humming-birds have been observed to visit, together with dates of their visitation. Humming-birds leave in the fall immediately after frost kills the humming-bird flowers. The chemical nature of the saliva used by the chimney swift in gluing its nest together was described by Althea R. Sherman and Burton H. St. John. L. J. Cole presented some data on determinate and indeterminate egg-laying, especially of the house wren. Jesse M. Shaver analyzed statistically various temperature factors as related to the time of ending of the mocking-bird's evening song. The distribution and taxonomic relations of the crowned sparrows were considered in a paper presented by Myron H. Swenk. An especially pleasing paper was the comparison of the old, sincere ornithologists of the past with the numerous publicity seekers and nature fakirs of the present, by Althea R. Sherman. Seven papers at this meeting were illustrated by motion pictures. The following officers were elected for 1930: *President*, J. W. Stack; *vice-president*, Frank L. Burns; *secretary*, Jesse M. Shaver; *treasurer*, W. M. Rosen; *councilors:* Albert Ganier, Myron H. Swenk, Mrs. Margaret M. Nice, Lynds Jones.

SECTION G (BOTANICAL SCIENCES) AND RELATED ORGANIZATIONS

(*Reports from Sam F. Trelease, Arthur J. Eames, A. S. Foster, F. E. Denny, G. W. Martin, W. A. Whitney and W. H. Horr*)

As in recent years, Section G arranged a single session of invited papers of general interest, held jointly with the associated botanical societies on Tuesday afternoon. C. E. Allen gave the retiring vice-presidential address on "Inheritance in a Hepatic." This very interesting address on Dr. Allen's fundamental botanical research in genetics was followed by a symposium on the biology of maize, in which G. N. Collins, Paul Weatherwax, E. W. Lindstrom and L. W. Durrell read papers on the phylogeny, ontogeny, genetics and pathology of maize. These papers, together with those read at a special session of Section O on maize, provided a very valuable summary of recent investigation on that important plant.

The Botanical Society of America held a most successful meeting from Monday to Wednesday, with a registered attendance of 260. The sectional meetings were unusually well attended, with much discussion. The annual dinner for botanists was held on Tuesday evening, with 221 present. President Margaret C. Ferguson presided, and retiring president A. H. R. Buller delivered the presidential address. Illustrated reports of the recent remarkably successful summer meetings of the society were presented by A. J. Eames and L. W. Durrell. The following officers were elected: *President,* L. W. Sharp; *vice-president,* R. H. True; *editor-in-chief,* E. W. Sinnott.

At three well-attended sessions of the General Section of the society topics in paleobotany, cytology, morphology and anatomy were considered. By means of lantern slides, the details of tracheary pitting and the relationship of primary to secondary xylem in fossilized wood of Callizylon were clearly demonstrated. The anatomy of the so-called "pistol-butted" trees of mountain slopes occasioned discussion, especially in regard to physiological and developmental factors. A paper dealt with the origin of the cellular layers and the chemical nature of the cell walls in the seed coats of alfalfa and clover. Several papers were concerned with special phases of the morphology of cryptogams, and interesting reports were made on the development and structure of the gametophytes of various liverworts, on the monoecious gametophytes of several species of Equisetum and on the imperfect state of our knowledge of the life-cycle of the marine alga Leathesia. A paper on gamete formation in certain marine diatoms emphasized the need for further American research in this field. Several papers dealing with angiosperm morphology were read, and an observation on dehiscent sterile achenes in the strawberry was discussed. A preliminary report was presented on the morphology and initial ontogenetic divergence between cataphylls and foliage leaves in Oenothera and Eleocharis. A report of the detailed development of cotton fibers was of particular interest.

Three meetings of the Physiological Section of the Botanical Society were held. Of special interest were invited papers by Ernest Bateman, of the U. S. Forest Products Laboratory, on toxicity of chemicals to fungi, and by E. J. Lund, of the University of Texas, on bioelectric currents in plants as related to the life activity and correlation of cells. Lund's report was supplemented by papers by Gordon Marsh on the inherent electromotive force of the onion root tip. There were five papers on the general subject of plant nutrition: Wanda K. Farr showed growth curves of root hairs in solutions of calcium phosphate at different pH values; Sophia H. Eckerson gave the results of a microchemical study of tomato plants during phosphate starvation and recovery; Mary E. Reid presented further reports on the nitrogen metabolism of squash under different conditions; F. B. Wann reported on the effect of iron salts on the recovery of plants from chlorosis, and Wann and E. O. Leonard showed the relation of nitrates to the growth of cuttings of *Mentha piperita.* Two papers dealt with the virus problem: A. A. Dunlap showed that the mosaic and yellows diseases had contrasting effects upon the carbohydrate and nitrogenous substances, and B. M. Duggar gave a further report upon the inactivating effect produced by the addition of various substances to tobacco virus. J. B. Overton and E. A. Cockefair found that in the aging of century-old cells of cactus the chemical changes were much more marked than the cytological changes. G. J. Peirce was able to introduce starch suspensions into the petioles of plants and thus follow the path of conduction in the vessels. Adelia McCrea noted a favorable effect of ultra-violet light upon the potency of *Digitalis purpurea.* Measurements of the internal and external temperatures of leaves were reported by J. C. Frazier and E. C. Miller. There were two papers on respiration: by F. G. Gustafson on tomato fruits and by B. E. Livingston and W. B. Mack, who reported a double optimum in oxygen concentration. Other subjects treated were: regeneration of tissues by cuttings, glucosides of Marrubium, reducing substances in plants, rest period of seeds and buds as related to storage conditions and chemical treatments. The officers of the Physiological Section for 1930 are:

Chairman, E. N. Transeau; *vice-chairman*, E. F. Hopkins; *members of the board*, B. M. Duggar and L. Knudson; *secretary*, F. E. Denny.

The Mycological Section held two sessions, notable for the unusual attention paid to the Phycomycetes. F. B. Cotner discussed the development and cytology of zoospores of the Oomycetes under controlled temperature conditions; E. M. Gilbert and W. A. Kuntz made significant contributions to the life histories of species of Empusa. Papers on fungi of other groups included those by Leva B. Walker on *Ascoidea rubescens*, by A. H. R. Buller on Sporobolomyces and by B. O. Dodge on microconidia of Monilia. The section approved a projected program in commemoration of the hundredth anniversary of the birth of Anton de Bary, to be presented in cooperation with the American Phytopathological Society, at the Cleveland meeting next December.

The American Phytopathological Society held its twenty-first annual meeting from Saturday through Tuesday with an attendance of about 150. The officers for 1930 are: *President*, H. S. Fawcett; *vice-president*, Max W. Gardner; *secretary-treasurer*, F. C. Meier; *councilor*, H. P. Barss; *editor-in-chief of Phytopathology*, H. B. Humphrey. The program consisted of ninety-three papers delivered before the society's sections and five delivered at two joint sessions, with Section G of the American Association and with the Society of American Bacteriologists. The contributions may be classified as follows: cereal diseases, twenty-five; vegetable diseases, thirty-two; fruit diseases, thirteen; miscellaneous diseases, twelve; diseases of ornamentals, nine. There were two invited papers, by Christine Buisman, on the Dutch elm disease, and by R. P. White, on the future of the pathology of ornamentals. The annual banquet on Saturday evening will long be remembered because of the clever program of original songs, impersonations, etc., rendered by members from Iowa, Minnesota and Wisconsin. On Sunday evening was held the second annual meeting with business men and farmers, the discussion being this year on "What Present Trends in Agriculture Demand of Plant Pathology." Thomas Roberts (General Milling Company) spoke on the great west and wheat; the nation's greatest crop, corn, was discussed by H. A. Wallace (Wallace Publishing Company); the sugar-beet industry was represented by W. H. Baird (American Beet Sugar Company), and a paper on conserving the intensive crops prepared by C. G. Woodbury (National Canners Association) was read.

The Monday sessions were held at the Iowa State College, at Ames, where there was an elaborate exhibit of experimental work. Displays of virus diseases, crown-gall investigations and corn seed treatments were noteworthy. There were three simultaneous sessions Monday morning and a joint session in the afternoon with the Society of American Bacteriologists, with papers on bacteriophage and plant and animal viroses.

The extension pathologists held a round-table discussion on Tuesday with R. E. Vaughan, of Wisconsin, as chairman, who emphasized the importance of disease control projects in close cooperation with other extension work, the extension pathologist being the contact agent between investigator and farmer. From the contributions the following are mentioned at random. The Dutch elm disease, caused by *Graphium ulmi*, was described by Christine Buisman, who pointed out the dangers should this fungus cross the ocean. Margaret Newton, Thorvaldur Johnson and A. N. Brown, and E. C. Stakman, M. N. Levine and R. U. Cotter, reported independently upon the hybridization and mutation in *Puccinia graminis*. J. C. Walker showed that resistance to cabbage yellows was inherited as a dominant character. The status of late blight of tomatoes in California was discussed by G. B. Ramsey and Alice A. Bailey. Texas root rot of cotton was described by Walter N. Ezekiel and J. J. Taubenhaus. The toxicity of flax extracts for *Fusarium lini* was correlated with the susceptibility or resistance of the variety from which the extracts were taken, stated E. S. Reynolds. Injury to apple leaves and limbs due to spray oil was reported by P. A. Young. The seasonal development of crown gall and hairy root were described by A. J. Riker, E. Hildebrand and G. W. Keitt. John E. Sass reported on histological studies of apple callus knots. The movement of the crown-gall organism through the tissues of the tomato plant was described by Spas Ivanoff and A. J. Riker. Years when pomaceous fruit diseases are prevalent, stated L. R. Tehon and G. L. Stout, are those years when drupaceous fruit diseases are relatively unimportant. The present status of tomato bacterial canker was discussed by Mary K. Bryan. Selection of plants and plot screening again proved successful for the control of aster yellows, as reported by L. R. Jones and Regina S. Riker. L. O. Kunkel reported a disease of tomatoes apparently identical with aster yellows. The emetic substances in scabby barley are apparently associated with glucosides and basic nitrogen compounds, according to Allan D. Dickson, Karl P. Link, B. H. Roche and James G. Dickson. Transmission by various insects of two potato-virus diseases was reported by R. W. Goss. Two virus diseases of the jimsonweed appear to be related respectively to diseases of similar nature in tomatoes and potatoes, according to

R. W. Samson. A method for recording the distribution of copper dusts and sprays on leaves was described by F. M. Blodgett and E. O. Mader. H. M. Quanjer reported on the comparison between the American and European leafroll of potatoes. Factors affecting the development of the aecial stage of *Puccinia graminis* were discussed by Ralph U. Cotter. The presence of the mycelium of *Peronospora schleideni* in onion flowers was described by H. T. Cook. G. B. Ramsey and Alice A. Bailey stated that ultra-violet light stimulates sporulation in *Macrosporium tomato* and *Fusarium cepae*. B. M. Duggar described the use of diatomaceous earth filters as standard technique in clearing expressed plant juices. Stomatal infection of tobacco by mosaic was reported by Burt Johnson and B. M. Duggar. Histological changes under mosaic infection were described by Melville T. Cook.

The annual dinner of the American Society of Plant Physiologists occurred Monday evening, with eighty-five members present. The address of President S. V. Eaton was on "Mineral Nutrition of Plants with Special Reference to Sulphur." J. B. Overton announced the first award of the Stephen Hales prize to D. R. Hoagland, and J. H. Gourley announced that C. A. Shull and G. T. Peirce were elected to Charles Reid Barnes life membership.

Thirty-five papers were presented in the regular sessions and eight in the joint session with the American Society for Horticultural Science. R. B. Harvey discussed storage temperatures and freezing injuries to vegetables, and time and temperature factors in the hardening of plants. According to P. W. Rohrbaugh, heat precipitable colloids are produced in the hardening process in apple-trees. T. N. Martin found for sweet clover a shift in growth from tops to roots beginning about October 1. Eric Ashby reported that *Lemna minor* showed a much greater development in a medium containing minute quantities of organic matter than in an inorganic medium containing the same elements, suggesting the presence of auximones. Charles Sheard and A. Frances Johnson found a change in electric potentials and currents produced in plants under various types of radiant energy; leaves "take a coat of tan" under ultra-violet irradiation. Walter F. Loehwing reported that increased light intensity decreased the acidity of the expressed sap of wheat seedlings. F. M. Andrews moved protoplasm from one sieve tube to another by centrifugal force but could not move the layer adjacent to the cell wall.

At a session devoted to corn and small grains J. D. Sayre presented a paper on a method for extracting sap from maize plants, and V. H. Morris proposed a method for the quantitative analysis of the expressed sap. W. E. Tottingham's investigations showed that temperature did not affect the nitrogen content of maize but that the shorter waves of visible light favored the intake of nutrients from water cultures. George H. Dungan told how the removal of leaves lowered the quantity or quality of corn according to the time of their removal. In similar work W. E. Loomis showed that 20 per cent. of the leaves of tasseled corn was necessary to maintain the vegetative structures, suggesting that (1) translocation is a limiting factor for photosynthesis in maize, (2) moderate decrease in leaf area does not produce a corresponding decrease in dry-matter production and (3) any influence that decreases the translocation rate retards photosynthetic activity. J. D. Sayre reported that demonstrable iron accumulated only around the veins at the nodal plates in maize. V. H. Morris found a gradual increase in dry matter in the stem from the time of tasseling to maturity; reducing sugars were about equally distributed in all parts of the stem and decreased with maturity, but half of the sucrose was found in the lowest four joints.

In the session with the American Society for Horticultural Science Charles Sheard discussed germination, stalk length, leaf area, wet weight and chlorophyll development in plants grown under vita-glass, ordinary window glass, blue glass and amber glass, respectively. J. R. Magness reported a correlation between number of leaves per fruit and fruit size; with twenty leaves per apple the fruit size was 50 per cent. greater than with ten leaves per apple. W. P. Tufts presented observations on seasonal temperature and fruit ripening in certain California valleys. Ora Smith reported on the rest period, interior gas analysis and permeability to gases in potatoes stored in wet and in dry surroundings at different temperatures. P. A. Young reported greater absorption of oil into the leaf at the margin of a drop of spray than at the center of the drop. J. H. Gourley and E. F. Hopkins found no difference in keeping quality between apples from trees receiving the normal amount and those receiving three times the normal amount of nitrate fertilizer, even though the nitrogen content of the fruit was appreciably greater in the latter instance.

At the final session W. E. Tottingham described methods of presentation used by him in teaching plant biochemistry. H. P. Cooper, working with forty-five samples of pasture grasses, found that the metallic constituents with high standard electrode potential were apparently selectively absorbed. J. E. Weaver and W. J. Himmel found a decided difference between Typha roots grown in water and those grown in well-aerated soil. Joseph C. Gilman and C. H. Barron reported that the temperature of germinating sterilized oats was raised 6.8° C. but that when *Aspergillus fumigatus* was present on oats with but 18 per cent. of water the temperature was raised 26.4° C. Robert P. Marsh reviewed his work on ferrous-sulphate treatment of clover and the accumulation of the salt in the leaves as shown by X-ray photographs.

ORGANIZATIONS RELATED TO SECTIONS F AND G

(*Reports from E. W. Lindstrom, A. O. Weese and P. W. Whiting*)

The American Society of Naturalists held a symposium on radiation on Wednesday afternoon. Selig Hecht spoke on "Radiation and Vision," describing and illustrating some newer methods of investigating quantitatively visual acuity in relation to the distribution of the rod-and-cone mechanism of the eye. By an ingenious experiment he demonstrated and projected in motion picture the visual response of Drosophila to a series of light stimulations calibrated to correspond with the theory of the random distribution of the light receptors in the eye. The results were startlingly satisfying and very consistent with our knowledge of eye structure. H. J. Muller spoke on "Radiation and Genetics," summarizing our knowledge on the production of mutations by X-ray, radium and natural earth emanations and showing the bearing of this on evolution. He said that if an electron has been able to knock out a portion of a gene (giving a retrogressive mutation), it has also been able to put it back again, making it possible for progressive variations to be thus produced. Robert Emerson, speaking on "Radiation and Photosynthesis," gave a critical survey of what is known of the relations between chlorophyll and light. He described some experiments on the relation of light and chlorophyll content to photosynthesis in the alga Chlorella, in which the chlorophyll content may be regulated at will by controlling the supply of iron in the medium. The rate of photosynthesis was found to vary almost directly with the amount of chlorophyll in the cell. An audience of 150 were well pleased with the program and with the remarks of the presiding officer, President G. H. Parker. A. F. Blakeslee was elected president for 1930 and Charles Zeleny vice-president. At the annual dinner Wednesday evening President Parker gave an address entitled "Kim Kurmah, or What Are We About?" with a humorous and searching analysis of the activities of the teacher and investigator in biology.

The Ecological Society of America met on Monday, Tuesday and Wednesday. The Monday afternoon and Tuesday morning sessions were held jointly with the Botanical Society of America and the American Society of Zoologists, respectively. The president's symposium, on the "Ecological Importance of pH," was of special interest, as was also a symposium on "Range Ecology," held at Iowa State College Wednesday afternoon. The society dinner was held at Ames Wednesday evening and was followed by an address, "Concerning Community Studies," by the retiring president, W. C. Allee. The following officers were elected: J. E. Weaver, *president;* W. P. Taylor, *vice-president;* A. O. Weese, *secretary-treasurer;* Barrington Moore, *editor.*

The American Microscopical Society held its forty-eighth annual meeting on Monday and elected the following officers for 1930: *president,* D. H. Wenrich; *first vice-president,* L. H. Tiffany; *second vice-president,* H. W. Stunkard; *member of executive committee,* S. Eddy. To honorary membership, the society elected Edward Pennock and Wm. Hoskins, who have maintained membership continuously since 1879. A $50 life membership was awarded to Samuel Eddy for securing the largest number of new members in the competition of 1929. A committee with Paul S. Welch as chairman was commissioned to draw up resolutions on the death of former secretary T. W. Galloway, for publication in the proceedings.

The ninth annual meeting of the Joint Genetics Sections of the American Society of Zoologists and the Botanical Society of America was held in part at Iowa State College, Ames, in part at Des Moines. At three sessions twenty-nine papers were read, among which a noteworthy contribution was made by Sewall Wright, entitled "Evolution in a Mendelian Population." Among exhibits and demonstrations was one by G. H. Rieman, illustrating genetic factors for pigmentation in the onion bulb and their relation to disease resistance. E. W. Lindstrom showed growing specimens of haploid tomatoes and of diploids derived both sexually and asexually from these, also microscopic preparations demonstrating chromosome segregation in haploid tomatoes. F. B. Hanson reported a striking parallelism between increasing X-ray voltage and lethal mutation in Drosophila, and also experiments demonstrating the effect of earth radiation in producing lethal mutations. Several papers reported new cases of linkage in plants and animals. It was voted that a committee be named to investigate the possibilities of organizing American geneticists and to report at the Cleveland meeting. Officers for 1930 are as follows: *chairman,*

L. J. Cole; *secretary-treasurer,* P. W. Whiting; *society representative,* L. J. Stadler.

SECTION H (ANTHROPOLOGY)

(*Report from C. H. Danforth*)

Section H held sessions on Monday. The early occurrences of man in America and the archeology of the Mississippi Valley were the two outstanding subjects discussed. The opinion seems to be gaining ground that man and mammoth existed contemporaneously on the American continent; but granting this (which many students are reluctant to do), the question still remains as to whether man appeared earlier, or certain extinct mammals persisted longer, than has heretofore been supposed. P. E. Cox, state archeologist of Tennessee, argued that man in America has an antiquity comparable to that of early man in other parts of the world. Harold J. Cook, of the Colorado Museum, discussed the paleontology of Colorado, Oklahoma and Texas in relation to human finds in this region, particularly the "Folsom man." E. B. Renaud, of the University of Denver, reported on the prehistoric culture of these people. Cook emphasized the association in this region of human bones with those of extinct forms of bison, mammoth, etc., in formations where recent species other than man are not represented. Suggestion of a possibly late persistence of the mammoth was found by William D. Strong, of Nebraska, in an interesting series of Algonkian myths whose source would be difficult to explain except on the basis of an original first-hand knowledge of living proboscidians.

A discussion of the present status of the Nebraska Indians and a tentative outline of the archeology of Iowa with many illuminating data on the history and geography of the state were presented, respectively, by A. E. Sheldon, of the Nebraska Historical Society, and Charles R. Keyes, of the Iowa Archeological Survey. An interesting contribution to physical anthropology was contained in a paper by George D. Williams, of Washington University, who finds that, irrespective of total stature or length of tibia, the fleshy belly of the gastrocnemius is shorter in proportion to total muscle length in the Negro than in the white subject.

There was a joint session with the National Research Council's committee on state archeological surveys, at which Carl E. Guthe presided. Dr. Guthe laid stress on the extent of unwitting vandalism and irreparable loss to science occasioned by uninformed amateur collectors, especially curio seekers. Bones and artifacts are practically valueless in the absence of the fullest possible information as to source and associations. These most important data are the very ones which are most often lost or rendered equivocal by the amateur and the poorly equipped museum. It behooves anthropology vigorously to discourage curio seeking, to promote a better appreciation of what facts are important and to strive for the type of cooperation between professional and amateur that has proved so mutually helpful, for example, in ornithology and in astronomy. In the vice-presidential address Dr. Fay-Cooper Cole stressed the importance of the anthropological view-point in the treatment of Indians, immigrants and dependent peoples generally. Examples from the experience of Dutch, English and other colonial powers were cited to show the excellent results that have commonly followed study of and concessions to native religions and customs as contrasted with the almost invariably disastrous outcome when these considerations have been ignored.

SECTION I (PSYCHOLOGY)

(*Report from John E. Anderson*)

The Des Moines program of Section I was the most extensive one ever arranged by the section, due in part to the fact that, owing to the holding of the Ninth International Congress of Psychology in September, no meeting of the American Psychological Association was held this year. On Friday morning there was a joint session with Section Q, devoted to invitation papers. George D. Stoddard, of the University of Iowa, discussed the objectives of research in child development, with many illustrations from the experimental literature; M. E. Haggerty, of the University of Minnesota, described the methods and progress of his extensive historical analysis of the literature on learning, and Frank N. Freeman, of the University of Chicago, presented the results of his important study on the resemblance of twins. On Friday afternoon a second joint session was held with Section Q for the presentation of the vice-presidential addresses. Howard C. Warren, of Princeton University, retiring vice-president for Section I, spoke on "The Organic World and the Causal Principle," giving a scholarly and constructive analysis of the relation between the doctrine of emergent evolution and the mechanistic interpretation of the universe. Truman Lee Kelley, of Stanford University, retiring vice-president for Section Q, spoke on "The Scientific *versus* the Philosophical Approach to the Novel Problem," bringing into clear relief the characteristic features and results of the two methods of approach. During the remainder of Friday afternoon and on Saturday five sessions were held for contributed papers, of which thirty were read. Four of these were in the field of general psychology, seven in experimental psychology, six in genetic psychology, seven in educational psychology and the remaining six may be classified as miscellaneous. The attendance at all sessions was unusually good, varying from 70 for the smallest session to 250 for the session at which the vice-presidential addresses were given.

SECTION K (SOCIAL AND ECONOMIC SCIENCES)

(*Report from Charles F. Roos*)

Sections K and M (Engineering) held a symposium on the relations of the social sciences and statistics to engineering, with invitation addresses. In a paper on "The Placement of Engineering Graduates before and after Graduation," John R. Bangs, Jr., of Cornell University, contradicted the somewhat current opinion that the engineering profession is slightly overcrowded. Professor Bangs proposed that engineering schools have a personnel officer who should obtain careful character and vocational analyses from many acquaintances of each student and from these prepare a rating for industrial organizations and for helping the student in picking the right kind of a position. He questioned the ethics of a minority of industrial concerns which try to force students into hurried decisions. In 1928 nearly five times as many positions were offered as there were men in the mechanical engineering graduating class of Cornell University, and the majority of starting salaries were in the neighborhood of $150 per month. During the last three years average starting salaries have increased about $2 per month per year. The old method of determining stresses and strains by picturing material as a continuous, homogeneous, isotropic substance, capable of being subdivided indefinitely without losing any properties exhibited in the bulk, is erroneous, according to F. B. Seely, of the University of Illinois, who read a paper on "The Statistical Element in the Mechanics of Materials." Experiments involving repeated stresses (fatigue of metals) and studies of the internal character of metals made possible by the use of the metallurgical microscope have produced considerable modification in our conception of materials, and material is now pictured as an aggregate of structural units varying as to size and shape, disposed at random orientation and containing internal discontinuities such as minute cracks and inclusions which are also distributed according to the laws of chance. For such a conception the problem of determining stresses is one where exact calculations can have no place, but occurrences are governed by probabilities and are susceptible to statistical analysis. In his paper on "Economic Quality Control of the Manufactured Article," W. A. Shewhart, of the Bell Telephone Laboratories, said that the aim in manufacturing is no longer to do exactly what we want to do, but to approach what we desire within certain limits. This revision in ideas brings with it a modification of methods of controlling quality all the way from the raw material to the finished product. By the use of probability and statistical theories it is now possible to control quality within limits and to obtain more economically a product which does not vary more than a specified amount which may be left to chance. Dr. Shewhart exhibited charts to show that his method actually works in the manufacturing of telephones and other equipment used by the telephone companies. Harold Hotelling, of Stanford University, gave a paper entitled "The Economics of Exhaustible Assets."

In his vice-presidential address on "The Future of Retirement Schemes for Superannuated Employees," H. L. Rietz, of the University of Iowa, took and defended the position that both the employer in industry and the public, as an employer for the public service, should clearly recognize retirement allowances as sound business and not as acts of charity. He predicted that there will gradually be a more and more pronounced drift towards retirement plans of the reserve, contractual type, operated by organizations as permanent and trustworthy as legal reserve life insurance companies and subject to state supervision similar to that exercised over life insurance companies. The remainder of the Monday program was devoted to invited and contributed papers by E. B. Reuter, G. D. Stoddard, C. I. Bray, E. D. Starbuck, W. G. Bergman, C. F. Roos and J. E. Brindley. Tuesday morning was devoted to a joint program with Section A (Mathematics) and the American Mathematical Society, the program consisting of papers by Henry Schultz, H. L. Rietz, H. Hotelling, G. R. Davies, P. R. Rider and H. A. Meyer. In an invited paper on "The Standard Error of a Forecast from a Curve," Henry Schultz, of the University of Chicago, employed a formula due to Gauss but the importance of which appears not to have been recognized before, and showed that forecasts of the population of the United States are subject to much larger "probable errors" than statisticians have generally supposed. Professor Schultz showed that, assuming that the well-known Pearl-Reed population curve is the proper one to use in estimating our future population, the chances are even that the actual population in the year 2100 will differ by more than ten and a half millions from the forecasted population of 196 millions. The accepted methods lead to a corresponding error of estimate of only a half million. Using for illustrations the production of hay in the United States and the growth of yeast under laboratory conditions, Professor Schultz showed further that there is no necessary relation between the goodness of fit of a curve to past observations and its reliability for forecasting the future.

SECTION L (HISTORICAL AND PHILOLOGICAL SCIENCES)

The work of Section L is carried on in two parts, with a committee for each part, including a chairman and a secretary. At recent annual meetings the programs of the two parts of Section L have been arranged by their respective affiliated societies—the History of Science Society and the Linguistic Society of America. Neither of these societies met with the association at Des Moines, but each of the two parts of the section was represented by a program of invitation papers. These two programs are reported separately below.

The History of Science Part of Section L. (*Report from P. E. Brown and B. E. Livingston*)—The program of the History of Science Part of Section L was presented Saturday forenoon and afternoon, in two joint sessions with Section O (Agriculture), with invitation papers. Charles E. Payne, of Grinnell College, presided at the forenoon session and made an introductory address, which was followed by a paper on "The Agricultural Revolution in the United States, 1860–1930," by L. B. Schmidt, of Iowa State College. "Some Pre-revolutionary Correspondence on Agriculture" was presented and discussed by Rodney H. True, of the University of Pennsylvania. George W. Hendry, of the University of California, gave a paper on "Adobe Brick as a Source of Agricultural History." At the afternoon session a paper on "Science and the New History" was presented by Irving B. Richman, of Muscatine, and one on "Some Means of Collecting Indian Lore" was presented by Edgar H. Harlan, of the Iowa State Archives. Both sessions aroused interesting discussion. At the close of the Saturday afternoon session a tour of inspection through the Archives of the Historical Memorial and Art Department of the State of Iowa and of the personal archives of Mrs. E. D. Spaulding was arranged by Mr. Harlan and Mr. Cassius C. Stiles. A paper on the history of science, entitled "Mathematics before the Greeks," was presented by R. C. Archibald, of Brown University, at the Monday afternoon session of the mathematical organizations. Some historical contributions were also presented before the American Meteorological Society.

The Linguistic Sciences Part of Section L. (*Report from J. P. LeCoq*)—The position of linguistics as a science and as the basis for the precise recording and transmission of scientific observation and thought is not always recognized, but an appreciation of these relations seems to be increasing. At a session on linguistics held Saturday morning, Stephen H. Bush, head of the Romance language department of the State University of Iowa, presented a paper on "The Duel of Louis and Gormont," an episode in a chanson de geste of the early twelfth or late eleventh century. Critics agree that this epic fragment relates in a highly unhistorical manner the story of the battle of Saucourt, which occurred in 881, and Professor Bush presented internal evidence to show that the duel episode must have taken its form at about that earlier time. The poem recounts in detail how King Louis used his spear as a sword or battle-axe, cleaving his opponent to the waist with one mighty blow, but spears that might have been employed in that manner were not in use in the eleventh and twelfth century and could not have been used at that time on account of the style of armor then in vogue. On the other hand, Professor Bush pointed out that the sort of spear required by the narrative was common among the Scandinavians of the ninth century, the thrusting and hewing weapon called "hoggspjot." It therefore appears that this detail must date from the earlier time. This conclusion is in disagreement with Bedier's widely accepted view that the chansons de geste are generally of the eleventh and early twelfth centuries and are not reeditings of much earlier poems. But it is in agreement with Lot's recent contention that the account considered is really a more recent form of a Scandinavian poem of the time of the battle referred to. Professor Bush's paper is to appear in *Modern Language Notes.*

In a paper on "The Arab and His Pen," by A. D. Veatch, professor of Semitic languages and literatures in Drake University, the speaker dealt with Arabic culture and literature as far back as the year 800. This contribution emphasized how very much modern science and philosophy owe to the Arabs. Valuable informal discussion closed the session, which was regarded as highly successful.

SECTION M (ENGINEERING) AND RELATED ORGANIZATIONS

(*Report from N. H. Heck and S. T. Hutchinson*)

Section M held a joint session with Section K (Social and Economic Sciences) on Saturday, which is reported above, under Section K. Section M held two Monday sessions, the programs for which were largely arranged by local engineers under the leadership of M. P. Cleghorn. The morning program covered a wide range, and that for the afternoon dealt with agricultural and industrial problems of Iowa and adjacent states. The retiring vice-president for the section, R. L. Sackett, developed the idea of a new science. Tracing the development of skill and the relation of science to special ability in the arts through the ages, he showed that skill is now adequate to supply the needed material and tools. The new science is the management of human energy in individual and group tasks. This necessary development must be by scientific methods and it is in the hands of the engineers. J. B. Davidson told of observations as a member of a special commission to Russia. He described the background resulting from complete substitution of new for old and discussed the five-year plan and its effects on manufacturing, communication and agriculture. The human element makes solution of the agricultural problem peculiarly difficult. C. C. Williams described the effect of vibrations on structures, separating them into harmless and harmful. J. S. Dodds, after pointing out the popularity of maps and their countless uses both in war and in peace, discussed the map-making program of the United States government. He showed that great benefit would result to the engineers and to the country if the recently announced plan, supported by the president and already authorized by Congress, to complete the mapping in eighteen years is carried out. N. H. Heck described the important practical uses of terrestrial magnetism in transportation, surveying and recently in aviation, radio transmission and geophysical prospecting. He showed that observations of high accuracy, made for these purposes, are fundamentally necessary.

Opening the afternoon session, M. P. Cleghorn described the excellent industrial progress of Iowa, which is primarily an agricultural state. He asked for the interest of engineers, especially those interested in research, in the problems confronting the state. O. R. Sweeny showed samples of materials developed from corn-stalks and other farm waste. These ranged in hardness from a substitute for teakwood through wallboard to a substitute for cork. He stated that desired qualities could be closely controlled in manufacture and that various useful chemicals are by-products. The supply of raw material is practically unlimited. S. M. Woodward described important hydraulic problems being undertaken at the Hydraulic Research Laboratory of the University of Iowa. T. R. Agg gave valuable information on recent developments in highway economics. He described how various elements of road and vehicle operation cost can be combined into a transportation cost and used in the planning of highways for particular needs. The problems are very complex, and many agencies are at work upon them. Paul E. Cox showed that it is greatly to the interest of Iowa to develop ceramic products. Henry Giese discussed the application of engineering to the farm. The mechanization of agriculture has made the American farmer the most efficient in the world, and power per agricultural worker is higher in Nebraska than elsewhere, with vastly greater value of annual crop per worker. The planning of farm power use, machinery and land reclamation all come into the field of the engineer, through whose efforts the agricultural industry is now in the condition in which other industry was fifty years ago. Further progress will depend largely on engineers.

At noon on Saturday thirty members and guests of the Institute of Radio Engineers held a luncheon, followed by an afternoon session of the mid-west section of the institute. J. C. Jensen, of Nebraska Wesleyan University, presided at the luncheon, and short responses were given by B. B. Brackett, Paul C. Rawls, H. D. Hayes and A. E. Kennelly. There was an attendance of sixty-seven at the afternoon session. "Problems of Television" were presented by B. T. Brackett, of the college of engineering, University of Nebraska, who brought out the present difficulties of procuring uniform brilliance and eye response. A paper on "Locating Radio Interference with the Oscillograph" by J. K. McNeeley and P. J. Konkle, of Iowa State College, was ably presented by Mr. Konkle. Slides were exhibited, showing that different types of interference give characteristic patterns on the oscillogram. Paul C. Rawls, president of the Technical Equipment Company of Des Moines, spoke on "Building Radio Transmitters for the Chinese Government." Difficulties due to white ants and humid atmosphere were largely overcome by use of glass and teak-wood. Eight hundred Chinese characters were built into a code system to care for the many different Chinese dialects. Equipment was built for military uses and also for government educational use. A paper on "The Variation of the Resistance of a Radio Condenser with Capacity and Frequency" was given by R. R. Ramsey, of the University of Indiana. The same speaker gave a paper entitled "Should the Load Resistance of the Tube be Rp or 2 Rp for No Distortion?" A paper on "The Measurement of the Magnetic Field Intensity inside a Coil

Carrying Radio-frequency Currents" was presented by Roy H. Mortimore, of Graceland College, Lamoni, Iowa. This paper is to be published in the *Physical Review.* Mr. H. D. Hayes, U. S. supervisor of radio for the ninth district, Chicago, told of "The Activities of the Radio Inspection Service in the Middle West," explaining in clear and interesting terms many features of the work of the Federal Radio Commission and its branches.

The session closed with a symposium on "Educational Broadcasting," with papers on "Courses Needed and Audiences Available" and "Organization and Finance." W. I. Griffith, director of WOI, Iowa State College, showed that the demand for programs of informational character is large and is steadily increasing. A referendum on the desirability of changing from high-grade music to jazz brought forth emphatic protest from the rural audience, of whom 98 per cent. favored the better music. Professor Griffith emphasized the value of market reports and the public interest in serious discussions. B. B. Brackett showed by charts and figures how an "educational chain" of stations, owned by institutions of higher learning and capable of telephone connections, will be able to send out master lessons and other educational material of high quality. At present there are fifty-six such stations in the United States, with a coverage of practically the entire country at night, and a few minor power additions would make similar daytime service available. H. M. Crothers, director of KFDY, South Dakota State College, was unable to be present, but his paper on organization of broadcasting by educational institutions was read by the chairman. Dean Crothers called attention to the necessity for maintaining high standards in the material broadcast, which necessitates adequate time for preparation on the part of faculty members who are to speak before the microphone. Both Dr. Brackett and Dean Crothers pointed out that colleges have on their faculties some of the best radio engineers in the country and are in a position to do first-class broadcasting work, also that they have available many men who are specialists and authorities in their fields.

SECTION N (MEDICAL SCIENCES) AND RELATED ORGANIZATIONS

(Report from C. W. M. Poynter)

Section N held sessions of its own on Wednesday and joint sessions with the American Veterinary Medical Association on Tuesday. The Wednesday forenoon session was presided over by Dr. Walter L. Bierring, of Des Moines. David I. Macht, of the Johns Hopkins University, presented a review of his work in the application of phytopharmacology to medical problems, using plants as physiological indicators for pharmacological tests. This paper created the greatest interest and was followed by a very lively discussion. In the absence of A. W. Rowe, of the Evans Memorial, Boston, his paper on "Endocrine Factors in Human Sterility" was read by J. T. Meyers, of the University of Nebraska College of Medicine. A review of the progress of Roentgenology and its contribution to medical science, by P. M. Hickey, of the University of Michigan School of Medicine, was read by Carleton B. Peirce, of the University of Nebraska College of Medicine, because of sudden illness of Dr. Hickey. The paper reviewed the steady advance of the Roentgen ray and its fields of usefulness, also the difficult problems in its employment. It is interesting to note here that the American Roentgen Ray Society has recently become affiliated with the American Association. In the discussion of Dr. Hickey's paper there was repeatedly brought out the importance of this affiliation and the opportunity it will furnish for further conferences, through Section N, with biologists and physicists who are interested, with members of the American Roentgen Ray Society, in many problems in which the X-ray plays an important part. The retiring vice-president for Section N, A. J. Goldfarb, of the College of the City of New York, was unfortunately unable to be present.

The Wednesday afternoon session was held for the public, with Dr. J. H. Peck, of Des Moines, presiding. William C. White, of the Hygienic Laboratory, U. S. Public Health Service, reported in detail on the procedure at present being adopted by students of tuberculosis. Dr. White's paper was very instructive and entertaining. J. W. Woodrow, of Iowa State College, described a new and exact method of evaluating vitamins in oil by means of the spectroscope, avoiding the long delays required to make the same determinations through animal feeding.

On Tuesday the entire day was devoted to a program arranged under the auspices of the American Veterinary Medical Association, recently affiliated with the American Association for the Advancement of Science. The meeting was very well attended, and gratifying discussion followed the reading of the papers. The contributions presented in the morning dealt with the menace of animal diseases to the human family. A paper by John R. Mohler, chief of the U. S. Bureau of Animal Industry, was read by Dr. Barger, in the unavoidable absence of the author. This paper presented a splendid résumé of the problems that were more specifically discussed in later papers. J. N. Shaw, of Oregon State Agricultural College, explained the poisoning of dogs by salmon, using a cinema film. M. C. Hall, of the U. S. Bureau of Animal Industry, reviewed our present knowledge of parasitology. A paper by William H. Feldman, of the Mayo Foundation, was devoted to an account of the production of experimental tuberculosis through intracerebral inoculation. C. H. Strange, of the Iowa State Veterinary College at Ames, discussed the general problem of veterinary education, and made the point, which was reflected in the atmosphere of this meeting, that the interests of veterinarians are much more closely associated with those of the medical fraternity than with the interests of the agricultural group, with which most veterinary schools have developed. This paper suggested a rather pessimistic outlook of the present status of veterinary education and urged the necessity of extended entrance requirements and closer organization with medicine. It was the general feeling, expressed in this discussion, that medical papers and veterinary papers should use common avenues of publication so that the compartmented literatures might become more easily available to both groups. It seemed to be the consensus of opinion that Section N might be peculiarly useful as a common meeting ground for these two groups.

On Tuesday afternoon the discussion centered around the problem of undulant fever. A paper by I. F. Huddleson, of the U. S. Public Health Service, presented the author's personal study in North Africa and Southern Europe. This was a very complete résumé and emphasized particularly the importance of contact in the extension of this disease to the human family. Dr. Jordan presented a paper by A. V. Hardy, of the U. S. Public Health Service, on "The Prevention of Undulant Fever," in which both the danger through contact and the possible extension of the disease through unpasteurized milk products were considered. The author concluded that contact is a more significant factor in the spread of the disease than milk products. Other papers of special interest can not be mentioned here because of lack of space.

SECTION O (AGRICULTURE) AND RELATED ORGANIZATIONS

(*Report from P. E. Brown, O. W. Tinker, H. B. Tukey and Paul Moore*)

On Saturday Section O held a joint session, morning and afternoon, with the American Society of Agronomy and the Geneticists Interested in Agriculture. The program consisted of a symposium on "Recent Developments in Research with Corn," arranged by John B. Wentz, of Iowa State College. The papers given dealt with genetics, morphology and physiology of the corn plant, diseases of corn, the utilization of corn products and the newer methods of corn breeding. The address at the annual dinner of Section O and related societies on Saturday evening was given by C. A. Mooers, of the University of Tennessee, retiring vice-president for Section O, who spoke on "Some Observations from Liming Investigations." A joint session with Section L on the "History of Agriculture" was held Saturday morning. A joint session with the Geneticists Interested in Agriculture, the Genetics Sections and the American Society of Agronomy was held on Monday at the Iowa State College, at Ames, the program dealing with the genetics of crop plants.

The Society of American Foresters held its twenty-ninth annual meeting on Monday and Tuesday, with an attendance of about one hundred members from all sections of the United States. About half of the time was devoted to a discussion of forestry and its relation to the public welfare. A proposed forest policy for the United States was submitted by a special committee, some of the phases considered being the question of idle land in relation to forestry, prospective future needs for forests and extension of public forests. These and other phases were discussed. Tuesday was devoted to discussions of many different topics, such as "Dissection of Wood Fibers by Chemical Means," "Environmental Controls for Game through Modified Silviculture," "Influences of the Forest on Erosion and Water Control," "Problems in Silvicultural Research." Announcement was made of the culmination of the plan of the Society of Foresters to employ a permanent executive secretary. The first award of the prize of $1,000, anonymously given to the society, for a paper covering the solution of the forest problem, was announced, Mr. Ward Shepard being the winner. Colonel H. S. Graves gave an account of progress made by the committee on educational survey, for which a gift of $30,000 was received from the Carnegie Corporation.

The twenty-sixth meeting of the American Society for Horticultural Science, on Monday, Tuesday and Wednesday, was the most successful yet held. In response to a special request the papers on the program were presented more clearly and with better illustrations than has been usual, and there was more discussion. A very successful banquet and social evening was an important feature, with an address by the retiring president, V. R. Gardner, of Michigan State College. A growing interest in vegetable problems was indicated by the fact that three half-day sessions were required for the papers presented in this sphere, and it was agreed that problems of ornamental horticulture were of sufficient interest to suggest a half-day session devoted to this field another year. Although breeding questions are still of great importance, only six papers out of the whole 107 on the program dealt with breeding. Pollination and self-sterility studies continued to exert wide appeal, especially the newer phases of caging, introduced bouquets and habits of pollinating insects. Propagation methods, one of the more recent fields of scientific attack in horticulture, likewise continued to be of interest. Fertilizer studies of a field nature, involving detailed plant nutrition work, dominated the program. Several reports from different regions were in general agreement that, while the composition of fruit was influenced by nitrogen fertilizers, the keeping quality was not affected. Several papers on small fruits discussed fruit-bud formation, cambial activity, runner formation in the strawberry, fruiting habits and methods of pruning, indicating a quickened interest in scientific attack upon small-fruit problems. It was shown that the six-cane Kniffin system of training grapes, as compared with the four-cane system, had increased the yield of grapes nearly 50 per cent. for a three-year period in Illinois. The problem of the physiological effects of sprays upon fruit plants, especially oil sprays, maintained its interest, although general spray problems have gradually become divorced from the program. Respiration and storage studies and problems of fruit ripening have, on the other hand, become of greater moment. Successful half-day joint sessions with the American Society of Plant Physiologists and with the Potato Association of America led to the decision that it will be desirable to hold similar joint sessions next year. A. T. Erwin, of Iowa State College, was elected president for 1930. The next meeting will be held at Cleveland, December 29, 30 and 31, 1930.

The Geneticists Interested in Agriculture held a symposium on Monday at Iowa State College, in joint session with the Genetics Sections and Section O, on "Genetic Experimentation with the Larger Domesticated Mammals." Papers were read by Jay L. Lush and Edward N. Wentworth, discussion being led by Bruce L. Warwick. The need of comprehensive records in connection with routine breeding operations was emphasized, to make possible the acquisition of new data in the field of reproduction physiology and in the study of character inheritance. Fred Griffee was elected secretary for 1930.

The sixteenth annual meeting of the Potato Association of America was one of the most successful yet held, with respect to general interest and large attendance. One and one half days were devoted to joint meetings with the Vegetable Section of the American Society of Horticultural Science and with the Iowa Vegetable Growers Association. Technical papers were presented on Tuesday and papers of a more popular nature were given on other days. A paper that aroused much favorable comment was on "The Potato as a Health Factor," by John Harvey Kellogg, of the Battle Creek Sanitarium. Dr. Kellogg cited results of experimental work to prove that the potato is an invaluable article of diet for the prevention of acidosis and other troubles of the blood. C. H. Metzger, of the Colorado Agricultural Experiment Station, reported that L. G. Schutte, of Monte Vista, Colorado, produced 1,145 bushels of potatoes from a single acre in 1929; this is the highest potato yield yet recorded for the United States. Papers on potato breeding were given by Wm. Stuart, of the U. S. Bureau of Plant Industry; Fred A. Krantz, of the University of Minnesota, and C. L. Vincent, of the State College of Washington. Dr. Stuart's paper, "An Historical Résumé of the Potato Since its Discovery," will be useful to plant breeders for many years. An exhibit of potato seedlings from different regions attracted much attention; many of the new seedlings seem to have great promise and some may replace varieties now generally grown.

The Association of Official Seed Analysts of North America held its twenty-second annual meeting on Tuesday, Wednesday and Thursday. There were round-table discussions on "Public Service Programs for Seed Laboratories," "Seed Law Enforcement," "Cooperative Service among Seed Laboratories" and "The Interpretation of Germination." There were reports of committees on public service, legislation, cooperative service and research.

The Crop Protection Institute had its annual dinner Monday evening. It was stated that while the income of the institute was less than $3,000 eight years ago, for the past two years it had averaged about $50,000. Paul Moore said that to many it would seem strange to be talking of crop protection when the topic of the hour was distress of thousands because of surplus crops. Yet, were there any stoppage of the effort to control plague and pest we should soon hear not just the cry of the farmer, "O Congress, give us a bonus," but a national prayer, "God, give us food." Mr. Moore urged the need of the institute for a small endowment that would provide for some "overhead" and some projects for which funds can not be secured from industry. W. C. O'Kane, chairman of the board of governors, indicated some of the work of the year.

Fifteen major research projects were continued or begun, carried on in seventeen states, with seventeen research men on the institute staff, of whom thirteen were full-time men. The projects ranged from plant breeding to the utilization of chemical by-products. Among the concrete accomplishments of the past year were mentioned: adaptation of an emulsified white oil to use against insects on domestic animals; a new method of wrapping fruit-tree grafts; a new material derived from petroleum products and adapted to extensive use in spraying; an efficient summer spray derived from petroleum oils; definite progress toward utilization of shale oils in plant sprays; a new combination fungicide and insecticide that is practical and efficient; utilization of a special form of sulphur in such a way as to meet extensive orchard needs. The institute unanimously adopted a resolution favoring an effort to eradicate the Mediterranean fruit-fly.

SECTION Q (EDUCATION)

(Report from W. L. Uhl)

Of the experimental studies in elementary education reported to Section Q, those by Ernest Horn, of the University of Iowa, and by Harry J. Baker, of the Detroit public schools, are of general significance. Dr. Horn showed that much effort has been misdirected in attempts to teach rules for spelling, which have but slight value. Dr. Baker illustrated the treatment of problems in character training by beginning with cases of maladjustment and then proceeding by diagnoses and remedial measures to the improvement of conduct. The relation of class size to the efficiency of teaching in high schools and colleges was reported upon by Everett Davis, of the Des Moines public schools, and by Earl Hudelson, of the University of Minnesota. The results point to the desirability of larger classes in some subjects if certain conditions other than size of class are satisfied. Difficulties in the education of the consumer were set forth by Rosamond Cook, of the University of Cincinnati, in a report upon the consumer's judgment of hosiery. Investigations on the effectiveness of learning and the significance of academic success were reported by D. A. Worcester, of the University of Nebraska, by G. C. Brandenburg, of Purdue University, and by Harl R. Douglass, of the University of Minnesota. Studies of the measurement of pupil and teacher growth and ability, as presented by S. A. Courtis, of the University of Michigan, by Herbert Sorenson, of the University of Minnesota, by S. L. Eby, of the University of Cincinnati, and by W. S. Bergman, of the Detroit public schools, attested progress in the refinement of procedures, the accuracy of measurement and the clearness of the presentation of data. Reports of studies on science teaching aroused much interest. Otis W. Caldwell, of Columbia University, presented evidence to indicate that the general policy of a school or the arrangement of its curricula may lead either the ablest or the weakest pupils toward science courses or away from them. Benjamin C. Gruenberg, of New York City, presented evidence to show that the alleged tyranny of science often has its roots in the hearts of propagandists and misguided enthusiasts for certain interpretations of science. Ways of avoiding such misconceptions were outlined by Florence G. Billing and S. R. Powers, of Columbia University, in their report upon a thorough and authentic professional course for teachers, a course planned to provide elementary teachers with training for their work no less sound than that now given to university teachers. Extended discussion followed papers read by Ralph K. Watkins, of the University of Missouri, by Elliot R. Downing, of the University of Chicago, and by Victor L. Noll, of the University of Minnesota, on the relative effectiveness of the laboratory and the demonstration in science teaching. The investigation of this problem has progressed so far as to warrant science teachers in trying courses with less laboratory work and more reading and discussion than is generally prevalent. Two sessions were held jointly with Section I (Psychology). F. N. Freeman, of the University of Chicago, summarized his study of twins with regard to the relation between nature and nurture. M. E. Haggerty, of the University of Minnesota, gave a paper on "The Incidence of American Psychology in the Problem of Learning." The address of T. L. Kelley, of Stanford University, retiring vice-president for Section Q, was on "The Scientific *versus* the Philosophic Approach to the Novel Problem." An empirical or theoretical approach, Dr. Kelley asserted, can be only a guess, and the rationalization of this guess may lead to disastrous and persistent dogma.

ORGANIZATIONS RELATED TO THE AMERICAN ASSOCIATION AS A WHOLE

(Report from Edward Ellery, Ellen Eddy Shaw, Ray M. Peterson, R. W. Babcock and Helen Jean Brown)

The thirtieth annual convention of the Society of the Sigma Xi was held at Des Moines, with President F. R. Moulton in the chair. The convention was the largest within the last five years; thirty-six of the fifty-one chapters were represented, each by one or more delegates, and twelve of the twenty-two Sigma

Xi Clubs were represented. The secretary reported that the total membership is now about 23,400 and that the chapter enrolment is between 7,000 and 8,000, a total of 804 members and 449 associates having been elected in 1929. He also stated that the committee on awarding Sigma Xi research grants had distributed, in 1929, approximately $4,000 among eight candidates. The convention unanimously voted charters for chapters to petitioning groups from the University of Wyoming, the University of Oklahoma, the State College of Washington, the University of Rochester and the Pennsylvania State College. Officers for the ensuing biennium were chosen as follows: *president*, George W. Stewart; *secretary*, Edward Ellery, Union College, Schenectady; *treasurer*, George B. Pegram; *member of the executive committee*, to serve five years, Leon J. Cole; *member of the alumni committee*, to serve five years, C. E. Davies. The annual Sigma Xi dinner followed the convention. The eighth annual address, presented under the joint auspices of the American Association and the Society of the Sigma Xi, was given by George H. Parker, of Harvard University, on "Some Aspects of Human Biology."

The American Nature-Study Society met on Friday and Saturday with an attendance of about seventy. Nineteen papers were read. An address of welcome to Des Moines was given by Agnes Samuelson, superintendent of public instruction for the State of Iowa. Miss Samuelson welcomed the organization in the name of the thirteen thousand schools in Iowa and three quarters of a million school children. Otis W. Caldwell, of Columbia University, spoke in memory of Alice Jean Patterson, of Normal, Illinois, who died in 1929. Papers on "The Evolution of the Nature Study Idea" were given by M. A. Bigelow, of Columbia University, and by Elliot R. Downing, of the University of Chicago. Dr. Bigelow said that the most successful nature study of recent years is simple observation of natural things, studied with reference to the children's interest rather than as illustrations of principles of organized natural science. Dr. Downing considered the centers of nature-study work in the United States, beginning with the Oswego Normal School, where Henry Straight, a pupil of Agassiz, took charge of science lessons in 1876. Later, in Cook County Normal School, Jackman did a piece of work similar to Straight's. L. H. Bailey and the Comstocks, at Cornell University, M. A. Bigelow, at Columbia University, and Clifton Hodge, at Clark University, established the present basis for American nature work. A paper by Florence Billig, supervisor of science, Sacramento, California, on "An Analysis of the Scientific Background of Students Enrolled in Courses in Science for Teachers in Elementary Schools," considered about nine hundred teachers and their science equipment when entering college or training classes. It was shown that less than 50 per cent. of these had studied even one science in high school and that many had no foundation in science, the entire responsibility for their preparation being thrown upon teacher-training colleges and normal schools. A most interesting science chart showing work for the first seven grades was presented by H. A. Beall, of the University of Iowa. Copies of the chart may be obtained upon request. A very excellent exhibit of pupils' work in nature study in the City of Des Moines was an important feature of the meeting. On Saturday evening, the annual nature-study banquet was held in honor of the presidents of the Nature-Study Society. Homer R. Dill, of the University of Iowa, gave the lecture of the evening. For 1930 the president is Bertha Chapman Cady and the secretary is Ellen Eddy Shaw.

The Honor Society of Phi Kappa Phi held its eleventh biennial convention on Tuesday, with an address by George W. Stewart, of the University of Iowa, on "Conservation of Talent." The secretary's report showed that 3,433 new members had been enrolled in the last two years, one new chapter having been installed. National officers were elected as follows: *president*, R. C. Gibbs; *secretary*, C. H. Gordon; *historian*, J. S. Stevens; *editor*, R. M. Peterson.

The Gamma Alpha Graduate Scientific Fraternity held its annual council meeting and convention on Monday and Tuesday. Seventy-one members were present at the breakfast, representing thirteen of the sixteen chapters. The officers for 1930 are: *president*, C. C. Murdock; *vice-president-secretary*, R. W. Babcock; *treasurer*, C. E. Mickel; *editor*, C. F. Scofield; *recorder*, S. S. Humphrey.

Sigma Delta Epsilon, Graduate Women's Scientific Fraternity, held its eighth annual convention following a breakfast on Tuesday morning, with about forty members present. The national officers elected for 1930 are: *president*, Helen Jean Brown; *vice-presidents*, Opal Wolf and Helen R. Johnson; *secretary*, Mary Dover; *treasurer*, Maude Bennot. About seventy-five members and guests were present at the breakfast, representing thirty-six institutions. Stella M. Hague gave a short history of the organization. Bertha Van Hoosen, editor of the *Woman's Medical Journal*, spoke on "Opportunity for Women to do Research in Medicine." Jane Leisenring, of the University of Minnesota, gave a talk on "Recent Advances in Nutrition."

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THE GERMINAL BACKGROUND OF SOMATIC MODIFICATIONS[1]

By Dr. M. F. GUYER

DEPARTMENT OF ZOOLOGY, UNIVERSITY OF WISCONSIN

On the theory apparently that all pleasures must carry a penalty of compensatory pain, some former grim group of zoological Puritans decreed that though this organization may eat, drink and be merry, it must in the end endure a retiring address, so-called presumably because it conduces to the usual result of retiring, sleep. No vice-president of Section F is ever brave enough to break the bonds of this ancestor worship, so you and I, fellow zoologists, are here alike victims of a tradition. Let's be merciful!

In venturing to speak briefly on the germinal background of somatic acquirements, you will observe that I have reversed the traditional order of this combination, the germinal foundation preceding the acquirement. Possibly this is the only novelty you will find in my remarks. But since general topsyturviness is the order of the day, I can at least plead modernity. In these days when children run their parents, freshmen instruct their professors and wives support their husbands, why should not some of our venerable biological riddles be approached backward?

We used to dream of romance, with each yearning soul finding its unerring way to its predestined mate; we now talk of propinquity and endocrines. The dart of Dan Cupid seems slated for replacement by the hypodermic needle and a proper blend of hormones. We used to hear of sin; we now know only psychoanalysis and unsatisfied self-expression. We used to read of prepotencies and pointings, but this lore of the fancier has given place to the chemistry of the gene. So in such precedents of revolution and disillusionment I would again justify my means of approach to a very old problem.

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[1] Address of the vice-president of Section F—Zoological Sciences, American Association for the Advancement of Science, December 31, 1929.

The possibility of modifying germ-plasm stands as a perpetual challenge to the biologist because the problem of variability, of the origin of new characters, constitutes the very foundation of both genetics and evolution. Until we know more of the causes of germinal variation than we do to-day, we must remain ignorant of the most essential factor in each of these fields. So it is obvious why, although baffled at almost every turn, the experimenter returns again and again to his attack on the central problem.

Great skepticism prevails among geneticists about interventions of the parental body affecting the germ-cells, particularly in any specific way. Since on the basis of negative evidence at least, the efforts of the flesh seem unavailing in any perceptible modification of germ-plasm, the modern student of heredity almost universally falls back upon the non-committal conception of a directly varying germinal substance, and simply pleads ignorance of the causative stimuli, internal or external, that induce such changes.

The truth is that in the very setting of the problem of the inheritance of somatic acquirements, we are, from one point of view, faced by an apparently insoluble dilemma. For the very fact that a character can be acquired by the body carries with it the inescapable admission that the constitutional capacity for its appearance already exists. It is a commonplace of modern genetics that the characteristics of an organism require for their expression not only an adequate stock of germinal materials which we call genes, but a suitable environment. From this point of view, an acquired character is one in which not the *genic constitution* but the *environment* has been changed.

Such a statement of the problem, however, meets the immediate challenge of explaining how such an acquired character is related to the genes of the germ, but inasmuch as we do not know how any character, acquired or otherwise, is related to the germ, our ignorance is no more dense than it was before. Certainly if our modern knowledge of genetics teaches us anything, it is how little we know about the relationship that exists between the chemical complexes of the germ and the expressed characteristics of the body. We know that any so-called character of the body is the indirect, cumulative product of a long series of interactions of these original chemicals; that great numbers of genes must cooperate to produce even the simplest character; that no one of these genes more than another represents the character in any literal sense, and that any particular gene influences not only one but many characteristics of the body.

There is an increasing amount of experimentation, particularly with X-ray and with radium, which shows that external influences may directly affect germ-plasm and that the resulting changes may become hereditary. The brilliant successes of Muller[2] and his associates in this field through radiation of Drosophila are of so recent occurrence as to be fresh in the minds of you all. Muller, you will recall, by means of X-ray bombardments increased the frequency of mutation about 150 times. Many of the induced mutations were the same as had already been found to occur in ordinary cultures of Drosophila; many were new. As with all observed mutations, including the four hundred odd which have been discovered in Drosophila alone, most were detrimental to the organism. Likewise most of them were recessive. The results seemed to be the random effects of ultramicroscopic bombardments, since even the twin gene of the closely associated homologous chromosome remained unaffected. Since the gene must be a chemical as well as a genetical entity there seems no reason to doubt that the outcome is due to a permanent change in its molecular constitution. As Muller graphically puts it: "The roots of life—the genes—had indeed been struck, and had yielded." He points out, furthermore, the similarity of the X-ray mutations to natural mutations which have been found in Drosophila and concludes that "the minute amounts of natural radiation present almost everywhere in nature . . . some of it of terrestrial origin, derived from the radium and other radioactive substances in earth, water and air, and a smaller part of it of cosmic origin, apparently derived from the diffuse and distant factories of matter . . . all this natural radiation *must* be producing some mutations in the living things on earth."

Within just the past few months Babcock and Collins have announced actual experimental demonstration that short-wave radiations from the earth itself either cause mutation or affect its rate of occurrence. They exposed genetically similar strains of fruit-flies in two different localities, one the university campus at Berkeley, California, the other in Twin Peaks tunnel, San Francisco, where the rock gives off about twice as much radiation as does the campus soil. After five months of culturing in these respective localities a check-up of their records showed about twice as much mutation in the tunnel cultures as occurred in the campus controls. The mutation studied was a "sex-linked lethal" which caused all males to die before hatching, leaving only females in the new generation. The differential percentage in the two localities was found to be constant and consistent. And at the present meeting we have heard Dr. Hanson, although working entirely independently

[2] *Scientific Monthly*, December, 1929, p. 481.

and in a different region, report essentially similar results.

Thus, we can scarcely overestimate the importance of Muller's findings and of the corroborations, extensions and new applications by such workers as Weinstein, Hanson, Dobzhansky, Stadler, Whiting, Blakeslee, Buchholtz, Patterson, Harris, Oliver, Gowen, Babcock, Collins and others, for here at last we have a plausible escape from that hoary fiction, a "spontaneous variation." Whether or not we have the exclusive cause of gene mutations remains to be seen.

To many of us the outstanding perplexity in the field of variation is not so much the mere appearance of changes in the germinal substance as the appearance of the particular kinds of change that eventually lead to that hand-in-glove relationship between organism and environment that we call adaptation. The accomplished facts seem almost overwhelmingly to suggest that environment must play an important part in initiating as well as in conditioning particular kinds of germinal changes.

Time and again in the past, according to paleontologists, whenever conditions arose that would permit of the existence of new types of living organisms, forms admirably adapted to those conditions appeared. In some way the environment molded these new inhabitants to its bounds, and it seems well-nigh incredible—no matter what eons of time are vouchsafed us—to believe that this has been done merely by the negative method of killing off generation after generation of the non-conformists. For on such a basis not only has the adapted organism had to await the accidental occurrence of a favorable germinal variation, but of hosts of them, often highly interrelated, which then must be sifted and perfected by natural selection through innumerable generations to bring about that marvelous fitness which characterizes living things.

Muller himself[3] gives us an interesting argument favoring the view that, together with natural selection, the multiplicative power of mutated individuals, particularly the favored few as against those having disadvantageous or neutral changes, is all that is required for "turning accident into order," and he contends that natural selection need operate with barely enough stringency to permit the multiplication of that rare minority in a generation in which the new mutations have chanced to be favorable.

Not only the facts of intricate adaptation, however, but various facts of geographical distribution likewise incline one to suspect that altered function or environment, if long continued, is directly instrumental in molding the fauna of a given region; yet experimental proof of such direct influence is lacking. Particularly when one contemplates the highly specialized adaptations of many parasites does he feel skeptical of the doctrine of an all-sufficient natural selection based wholly on accidental variations. For the adaptive mechanisms or adjustments of many of these parasites, whether such internal forms as intestinal protozoa or such external ones as bird-lice, must be of comparatively recent origin. Since they are often so highly specific that they can not live on even a slightly different species of host, it is evident that they could have reached their own state of highly specialized adaptation only after the host itself had evolved into a distinct species.

As just the reverse of what appear to be more rapidly or recently adapted forms, we have, on the other hand, our so-called "persistent types" which have remained in sluggish apathy for countless eons while their more versatile brethren have run a wide gamut of evolutionary change. One wonders how their genes escaped this radiant bombardment which set so many of their contemporaries on a course of further adaptation; or if their environment put no premium on change, why they did not at least enter upon a course of non-adaptive evolution through the accumulation of chance hit-effects.

Then again we have to face the problem of what appear to be definite trends in evolution as evidenced by similar changes which have appeared in great groups of separate though allied genera and species of animals since their respective departures from the common ancestral group. I refer to what is sometimes termed orthogenesis, though I hesitate to use this term because it means so many different things apparently to so many different people, ranging all the way from some mystical inner perfecting principle, to merely a general trend in evolutionary development due to the natural constitutional restrictions of the germinal materials, or to the physical limitations imposed by a narrow environment. The impression is held by many students of evolution that certain variations are prone to occur more frequently and more widely than others, in various related organisms, and some believe that such changes, irrespective of whether they are helpful or harmful to the species, tend to accumulate in definite directions. If favorable, it is obvious that their perpetuation is more assured. Since, in a former paper, I have commented rather fully on various lines of this evidence, I shall not review them here. It is sufficient for present purpose to say that many investigators have pointed out parallelisms in variation which tend to appear in different branches of the same large group of organisms.

One of the most recent studies of the kind with which I am acquainted is that of Metcalf[4] called

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[3] *Loc. cit.*

[4] *Jour. Morph. and Physiol.* 45: 1, March, 1928.

"Trend in Evolution." In the Salpidae, for example, he finds the same trends in certain characteristics of gut, muscle and eyes appearing in both the solitary and the chain salps. These modifications are most pronounced in the phylogenetically highest groups. While in the colonial types the changes at their inception are probably adaptive or at least not disadvantageous, to the solitary salps they are harmful. Metcalf believes, furthermore, that certain of these evolutionary changes, even though not utilitarian, have been thrown back in the germ-plasm in some way so that they appear far earlier in the individual life cycle than their late phylogenetic origin warrants. Again, he is so impressed with the irregular occurrence of similar characters in subdivisions of such groups as the Opalinidae "along the stem and branches of the phylogenetic tree," as he phrases it, that he sees no reasonable alternative to the conception that the evolution of the family is largely a working out of tendencies inherent in the germ-plasm.

Many other examples of parallelism in related forms will come to the mind of any one who has made taxonomic studies. To take an example from the vertebrates, the same features of color and color-pattern, such as the formation of eye-spots, barring and the like, appear again and again in various genera and species of the pheasant subfamily (Phasianinae). If the original mutations were fortuitous they seem to have instituted a series of changes in definite directions. To be more specific let us glance briefly at the varying stages and types of ocellation to be seen in the interesting group of peacock pheasants (Polyplectron) regarded by systematists as intermediate between the peafowls and the pheasants in the narrower sense. In *Polyplectron chalcurus*, apparently the most generalized species, ocellation does not occur. The only hint of what is to be realized in the more specialized members of the group is found in a pronounced purplish and greenish metallic coloration on certain feathers of the tail. In the male of *P. emphanes*, while there are numerous green metallic iridescent areas on the feathers of the upper wings and back, they have not yet progressed to the condition of being definite ocelli, although on the tail of this same individual there are two transverse bands of ocelli. As a further extension, in the male of *P. thibetanum*, the small feathers of the wings and the feathers of the interscapular region bear distinct small purple ocelli ringed successively with black, light brown and white. The tail is also banded with ocelli. In the male of *P. germaini* the wing-coverts and back bear numerous green ocelli. In the common peacock, which belongs to a related genus, the conspicuous "eye-spots" on the tail are, of course, known to all. Thus this tendency toward the formation of eye-spots in various genera and species of pheasants, apparently hinted at even in the greenish-black iridescence so often visible in the tail-feathers of the common rooster, would seem to be the outcome of a germinal bias which finds different ranges of expression in different species. In some it occurs as eye-spots on the wing-feathers, in others, on the body-feathers; in one species there may be a single, in another two rows of ocelli across the tail. Since these patterns appear in collateral lines, it is obvious that they have not been derived directly one from another but are the outcome of a general tendency present in the group as a whole. One sees in its incipiency in one species a character which may have reached an advanced expression in a kindred group, or finds various more or less intermediate expressions in other related species. The very fact that, instead of existing as a medley of wholly unrelated elements, certain characteristics such as color markings can frequently be arranged as parts of a definite pattern or as stages in a general process indicates directional variation. If one chooses the features of bars and spots and their intergradations in the guinea subfamily (Numidinae) the story is much the same.

The paleontological record also affords many examples of what appear to be directed series of change, even in some cases seemingly to an overdevelopment of structure or to physiological disfunction which has meant final extinction of the species. In such cases possibly for formal explanation we might fall back upon the assumption of some influence of modifying genes or of different equilibria among modifying genes, but then we should have also the problem of accounting for the modifying genes and how they come to operate in seemingly so orderly and determinate a way.

With facts, or what appear to be facts, such as these facing us, then, without denying the probability of fortuitous gene mutations and their initiation by radiant emanations, there yet remains the possibility that mutations may also be otherwise engendered, or that once a gene mutation occurs it becomes more or less subject to other forces within the germ-plasm. Surely genes must be nourished like other living things, since they multiply and grow and apparently display the other characteristics of living matter. They must therefore be open to the vicissitudes which beset other living substance.

Is the gene itself, or that possibly larger vital unit of which it is a part, the fixed unvarying thing we tacitly regard it as being? May it not wax and wane in strength on occasion or may it not have primary and secondary parts like a molecule with side-chains, or be a polymeric particle which may have fewer or more molecular units? Bits of evidence are occurring which suggest some such contingency.

As far back as 1917 Emerson[5] suggested "temporary inactivation" of the gene in certain cases of variegation, and in a similar connection Correns[6] in 1919 conceives of the gene as consisting of a large molecule with variable numbers of duplicate side-chains attached so that "to each number of these side-chains would correspond a definite ratio of white and green in the mosaic plant." This idea of a central molecule and side-chains has a very familiar sound to the speaker inasmuch as he discussed such a conception at some length before the American Society of Naturalists, at Ithaca in 1910.[7] Again, in 1924, in attempting to explain variegation, we find Eyster[8] postulating *genomeres*, gene elements which can segregate during development. According to him these may or may not be chemically identical. Likewise in 1927 Lillie[9] questions the view that genes are always present in the same quantity. Earlier, in 1916, Sewall Wright[10] speaks of "four quantitative gradations of one factor, which determines the amount of the basic color-producing enzyme."

Perhaps the most elaborate and consistently worked out theory of quantitative gene differences is that of Goldschmidt[11] who, in his theory of balanced action of the gene, discusses at much length the effects of the same gene in different quantities. He has been led to his present position through his attempts to analyze cases of intersexuality which he is able to initiate at will in the gipsy-moth.

Experiments and studies in sex determination and sex control all tend toward the conclusion that each sex in addition to its own determiners also contains the genes for the production of the other sex. The actual sex of the individual, leaving out the question of sex hormones and of other possible modifiers, is determined by the quantitative relations between these two sets of genes. According to Goldschmidt one of these sets resides within the sex chromosome, the other outside it. Under ordinary conditions two doses of the gene within the sex chromosome, or in other words, two sex chromosomes, produce the sex represented by the chromosome, but with only one sex chromosome, the outside determiners prevail. Where the male is heterozygous for sex as in Drosophila the sex chromosome carries the determiner for femaleness, and where the female is the sexual heterozygote, as in Abraxas, the sex chromosome bears the determiner of maleness.

Goldschmidt succeeded in isolating different races of the gipsy-moth, of different sex-determining potencies; that is, different ones of them had different but typical quantities of the female- and male-producing genes respectively. By selecting his races Goldschmidt could get ones with quantities of maleness or of femaleness which, in the resulting cross, no longer balanced the quantities introduced from the other parent, with the result that, at will, any predictable degree of intersexuality up to and including sex reversal in either direction could be secured. In the gipsy-moth, since the female is heterozygous for sex, ordinarily two sex chromosomes indicate male, and one, female. However, by choosing a race with high quantities of the outside female-determining substance and crossing it with an individual in which the two sex chromosomes came from a race which possessed in these chromosomes a very small quantity of the male-producing gene, Goldschmidt secured what were actually females in spite of the fact that their gametic constitution (with two sex chromosomes) was that of males. He asserts, "If a given race is crossed in one direction with another test-race we can predict every result of crosses with all other races in every direction." And he goes on to say, "It is claimed as a fact that in our work on intersexuality different quantities of one gene have been studied."

Digressing from these special instances, Goldschmidt enlarges his conception to make it apply to all genes, drawing on such fields as multiple allelomorphism, irregular chromosome distribution and the like as the chief sources of his argument.

He conceives of the gene as operating through "the production of chains of reaction of definite velocities which are a function of the quantity of the gene in question." As to the nature of any given gene, he regards it as a "definite quantity of something (of course qualitatively different things in many different genes) linked with a chain of reactions with a velocity proportional *ceteris paribus* to its quantity." He believes with many others who have arrived at much the same conclusion that in the present state of our knowledge we can best regard it "as a type of enzyme and specifically as an autocatylist."

Again, such remarks about chains of reaction and catalysis have a familiar sound to the present speaker because in his 1910 paper[12] before the naturalists, already referred to (and even in an earlier paper,[13] 1907), he discussed at some length the probable functions of the chromosomes as the source of enzymes which initiate series of progressive reactions that result in chemical interactions. The following excerpts are as valid to-day as when they were written:

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[5] *Genetics*, 2, 1917.

[6] *Sitzungsber. Preuss. Ak. Wiss.*, 34, 1919.

[7] *Am. Nat.*, 45, May–June, 1911.

[8] *Genetics*, 9, 1924.

[9] SCIENCE, 66, 1927.

[10] Carn. Inst. Pub., 241, 1916.

[11] *Quart. Rev. Biol.*, September, 1928.

[12] *Am. Nat.*, 45, 1911.

[13] SCIENCE, June 28, 1907.

It is a well-known chemical fact, moreover, that when two or more progressive reactions are going on simultaneously, a quickening or retardation of the velocity of either, with the consequent precocious development of certain stages in the sequence, may lead to a partial or complete deflection of the original trend of the reactions and the formation of entirely different end-products than would otherwise have resulted. And velocities may be varied greatly by such factors as temperature and catalytic agents.

If in the comparatively simple cases of associated simultaneous reactions with which we are acquainted in non-living matter, relative velocities may so modify the results, we can readily realize of what tremendous importance regulation of this matter must become in living protoplasm where doubtless vast numbers of chemical reactions and interactions are going on at the same time. In fact, could we locate such a time-regulating factor in the germ-cell it would seem that we had accomplished a long stride toward an understanding of the controlling and coordinating mechanism which insures the appearance of just the proper substance at the right time in morphogenesis. It would constitute a qualitative as well as a quantitative regulator, for by determining quantity at any given time it determines what the next chemical reaction will be, and hence in the very doing of this, it necessarily conditions the chemical outcome of that reaction. As we have seen, temperature and catalytic agents are important factors in modifying the velocities of reactions in ordinary chemical processes, and inasmuch as under normal conditions of development the temperature factor is a fairly constant one, we are left to face the question as to whether in protoplasmic phenomena there is anything to correspond to catalyzers. Such substances we find in the enzymes.

In any epigenetic conception of the germ-cell—and this in greater or less degree seems to be the only plausible one to-day—we are forced, in explaining morphogenesis, to postulate the existence of some time-, quantity- and quality-controlling mechanism. The one evident class of substances in the germ-cells which can fulfil the necessities of the case are the ferments. For since they will determine the velocities of chemical reactions they must in consequence control the quantitative relations of the cell chemistry at any given unit of time. But from the very fact that where a large number of associated reactions are going on simultaneously, these quantitative relations at given stages of the chemical interchanges must profoundly influence qualitative results, we can not but conclude that this initial control of velocities must condition the qualitative results.

If we regard the chromosomes as centers of such a series of velocity-controllers, or, in other words, as sources of various enzymes, we can at once appreciate the necessity for having them so accurately balanced off in size and particularly in their quantitative relations one to another. For since the velocity of the reaction in a fermentable substance is determined not only by the presence of the ferment, but also by the amount of it, the quantitative relations of the ferments to one another would have to be very accurately maintained.

There is no obstacle in the way of supposing, furthermore, that if we regard ferments as of nuclear origin, the cytoplasm of a given tissue may not modify the ferment, as it itself takes on the necessary modifications for its own specific functions. We have good evidence that the production of ferments can be modified by even the substratum on which living organisms grow, and such a relation as this, close as it is, is certainly less intimate than that existing between nucleus and cytoplasm. For example, certain molds cultivated upon starch form diastase, but if provided with albumin they will produce instead a proteolytic ferment. Moreover, by gradually altering their other nutriments, yeasts can be made to utilize after a time various foreign compounds.

If, as all evidence indicates, ferments operate as catalyzers, then we must not forget that it is the very general belief among chemists that catalytic agents do not initiate the chemical reactions with which we find them associated, but that they only tremendously accelerate such reactions, or in a few known instances retard them. Since the nature of the building material must determine fundamentally the nature of the thing built, we must look outside the enzymes for much that will determine the peculiar individual outcome of the developmental processes. Leaving out of consideration for the present other functions the chromosomes may subserve, we might regard them as a sort of gauge for the feeding out of enzymes at the proper rate to bring about proper velocity reactions in the other cellular constituents, and perhaps regard the whole matter of mitosis and exactness in chromosomal distribution as a mechanism by which a quantitative metabolic regulation is maintained.

Looked at this way, the physical basis of heredity could not be considered a series of equipotent units, but rather it must be regarded as being composed of systems of units of different orders of organization and different degrees of coordination. Alterations in the configuration, constitution or relative positions of the unit constituents which represent the links of the main protein chain or ring, for instance, would precipitate much deeper-seated changes than would replacement of side-chains by those of different type, and such replacements would, in turn, doubtless appear objectively as differences of greater degree than those resulting from shifts in the composition or configuration of the individual side-chains.

If we consider that the supplying of the proper amounts and kinds of ferments is one of the important functions of the chromosomes, then we may suppose that in biparental inheritance each set of chromosomes is operating, probably catalytically, on a series of fundamental cell constituents that are largely common to both lines of ancestry; and that slight constitutional or configurational differences in corresponding enzymes bring about individual differences such as we recognize in the adult. We have already seen that different ferments within certain limits may act on the same substance and yield different results; consequently, in the intrusion into the egg of slightly altered enzymes in the chromosomes of the male, we should expect corresponding structural modifications to result.

Any influence which could effect constitutional or configurational changes in other essential constituents of the germ-cell would doubtless produce corresponding alterations in the adult. It is probable that not only changes of nuclear origin are reflected on to the cytoplasm, but that, conversely, cytoplasmic alterations may affect the nuclear constituents, for we have already seen how even the substratum may modify the enzyme factors in entire organisms such as molds and yeasts. Furthermore, there is no reason apparent why if the differences, no matter how produced, are modifications in the fundamental constitution or stereometry of the material affected, they should not persist permanently in the new germ-cells.

It would seem, in fact, that in the permanent effects of such reciprocal influences as here depicted for nucleus and cytoplasm, we might be able to account in large measure for the accumulations which have step by step been grafted on to the primitive protoplasm in its epigenesis toward the complex conditions of to-day, or in other words, in its racial evolution. Moreover, it is conceivable upon this basis how in later stages of phylogeny, as new chemical configurations or new chemical substances were developed, some of these could bridge back into relations with more primitively established substances and thus bring about ontogenetic short-cuts in development, or how, on the other hand, these abridgments might result in part from alterations in the more primitive molecular configurations.

I may seem to have run on to great length aimlessly, but I would simply point out that if a mere shift of tags is made, what in this earlier paper I regarded as chromosomal enzymic forci become "genes," and the account sounds much like a modern attempt to explain the action of genes through enzymic behavior.

I have not carried you through all this repetition, however, merely for the satisfaction of dressing up old stuff in new guise, but because I think that in its line of argument one may find some germ of thought about what I started to discuss, the germinal background of somatic acquirements. Among other things the citation of the relations of yeasts and molds to their substrates and the possibility of one eventually radically modifying the other may not be without significance in the chromosome-cytoplasm relation.

In what respects the germinal predispositions which permit of the appearance of so-called acquired characters under special conditions differ from the predispositions that lead to the appearance of inherited characters under usual conditions, no one knows. About all we can say is that in case of what is commonly regarded as the inherited character, the character is usually capable of reappearing in successive generations without being called forth each time by a specific environmental factor. But since, as we have seen, the potentiality of acquired as well as of inherited characters must in some manner exist in germinal protoplasm, the difference would seem to be one of degree or of fixation rather than of kind.

We have no reason to believe that the living substance of the germ-cells has any mysterious powers that are not shared by any or all of the somatic cells. In tissue cells we know that changed internal relations or unusual environmental stimuli may result in such diverse modifications as those of growth, hypertrophy, atrophy, hyperplasia, metaplasia and what not. Just as excessive exercise leads to overdevelopment of a muscle, so increased strain in bone leads to increased growth of bony tissue; if one of a pair of organs (lung, kidney, thyroid) is lacking or is destroyed the other soon adjusts and performs the function of the pair combined.

In many compensatory adjustments, as of enlargement of the hemolymph glands and bone-marrow following removal of the spleen, the compensating organ is not in direct connection with the one which is disturbed or missing. It seems probable that the inciting agent is carried by the circulating fluids of the body, although in higher animals one may have to reckon with the nervous system. If, however, a serum-borne agent may incite compensatory hypertrophy or other changes in tissue-cells, may not some serum-borne agents stimulate germinal protoplasm to additive functioning or other changes? It seems improbable that the germ-cells, bathed in the same fluids, nourished by the same food, stand wholly apart. If we had but a single side-chain in common between a protein of a somatic tissue and a protein of the germ, then anything that could affect one might well be expected to affect the other. In the endocrinal secretions alone one sees a series of powerful substances circulating through the body and producing profound effects in any or all of its parts. Both clinical and experimental evidence reveals that increase or diminution of an endocrine gland may be followed by marked alteration of bodily structure or function. When one sees how sex endocrines may experimentally be made to override genetic constitution itself in determining sex, he is tempted to regard the very male- and female-determining genes as possibly intracellular endocrinal structures. Since change in an endocrine gland may produce permanent changes in various tissues, may there not be germinal homologues of such tissue which may likewise be modified, particularly if repeated generation after generation? In an earlier paper[14] I have expanded upon this theme, especially as it might have significance in orthogenesis. Any internal or external agent which could affect particular constituents, nuclear or otherwise, of the somatic cells should, on the face of things, be able to influence homologous elements in germ-cells.

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[14] *Am. Nat.*, 56, March–April, 1922.

My own experiments in this connection, with immune sera, have already been laid before this society and I shall not subject you to the tedium of recounting them again. All I wish to say at present is that the experiments both on the effects of lens antibodies and on transmission of induced immunity are being repeated, this time with inbred stocks, and in the case of the lens work, with individual lens proteins. A small though sufficient number of successes are being secured from time to time to keep me encouraged and of the same opinion as that expressed in my earlier work. I still believe that the serological reactions of the body afford one means of breaking in upon the germ.

What apparently would have to happen to have an acquired become an inherited character would not be the germinal creation of the capacities for its appearance—these must already exist or it could not appear—but some sort of germinal fixation that establishes it as part of the more habitual expression of the germ-plasm. We commonly conceal our ignorance of the matter, to be sure, by talking about the "plasticity" of the organism, but this very plasticity must have genic implications, for the fact remains that the organism has the inherent capacity for acquiring the somatic modification.

That profound shifts in the organization of the germinal protoplasm may occur, particularly in the order of the appearance of characters in individual development compared with the order of their evolutionary acquisition, is evident when one regards the frequent precocious appearance of an adaptive mechanism far in advance of the conditions under which it is to operate. The eye of the unborn mammal, for example, develops long before it encounters the external agent light upon which it depends for its very significance. Yet, if our conceptions of evolution mean anything, the vertebrate eye must originally have developed in some functional cooperation with light, no matter whether we regard light as a causative or merely as a selective agent. Likewise the mammalian placenta, though among the latest of acquisitions in phylogeny, is one of the first things established in ontogeny. The point I would make is that, as time goes on, adjustments do come to pass in germ-plasm which may alter the chronological relations of hereditary acquisitions, and that this indicates that germ-plasm is not a fixed, inadaptable thing.

It would seem not improbable that any acquired adjustment, based on the casual potentiality of the genes of the organism, repeated generation after generation, would foster successive adapted generations of individuals until such casual reactions of the genic complex became its customary reaction. Obviously both types of potentiality must reside in germinal protoplasm. At present I see no explanation of how casual potentialities of the germ-plasm which permit of the somatic acquirement of characters become ingrained in the mechanism which underlies the more independently recurrent characters called hereditary, unless it is to be found in the quantitative changes in genes or of genic potencies. Evidence of such changes seems to be slowly accumulating. Once concede that the constitution of the gene can wax or wane and the way is open to the conception of how this might be induced through nutritive, toxic or functional means. It may be that when we learn more about the protoplasmic basis of ordinary hypertrophy, atrophy and habit-formation we may also see our way toward an understanding of the origin of inherited adaptations. Until we do so possibly we shall remain in ignorance of this most elusive attribute of all living things.

THE NATIONAL ARBORETUM[1]

By Dr. FREDERICK V. COVILLE

ACTING DIRECTOR

The National Arboretum is an institution for the increase and diffusion of knowledge concerning trees. The National Arboretum Act, approved by President Coolidge on March 4, 1927, states that the purpose of the arboretum is research and education concerning tree and plant life and that in order to stimulate research and discovery the National Arboretum shall be under scientific direction.

To study the living tree, to breed new kinds, to select the best among them, to develop methods of propagating them, to show to what soils and to what situations and to what special purposes they are best adapted, such is the field of experiment and discovery to be occupied by the National Arboretum. The human race has bred sheep and cattle and horses, but not elephants. The elephant is too big, too wild, too long-lived. The human race has bred wheat and potatoes and apples, but not timber trees. They also have seemed too big, too wild and too long-lived. Bu the time has come to begin.

A strange case of the superiority of an individu tree has recently come to light, in a most unexpected way. One of the soil chemists of the Department of Agriculture, Mr. W. O. Robinson, amuses himself at home by making bows and arrows and shooting them. He has made bows of every kind of resilient wood the world affords, so far as he has been able to obtain it. One of the very best woods for bows is yew, which our own ancestors in western Europe used when they were savages, and which the Klamaths, Modocs and other Indian tribes of our northwest coast used until we brought them the rifle. But a yew bow is not durable. It loses much of its elasticity and strength after a few years of alternating heat and cold. There is another American wood, however, from which are made bows of such superiority and such lasting qualities that in the old Indian days they were handed down from father to son. This wood is the Osage-orange, the *bois d'arc* of the early French trappers, corrupted into *bodark* by Mississippi Valley frontiersmen, and made into a scientific name *Toxylon,* or bow wood, by one of the early botanists. The best commercial supply of Osage-orange comes from Texas. With this wood Mr. Robinson has made many bows of remarkable performance, a typical bow of forty-nine pounds pull weighing 25.1 ounces. Last year Mr. Robinson made the discovery that from an Osage-orange tree in an old hedge on the farm of a friend near Rockville, Maryland, he could get equal strength and elasticity with little more than half the usual weight of wood. From this tree he made a bow weighing 17.7 ounces, which has a pull of sixty-two pounds. With this bow he shot an arrow 341 yards, a far greater distance than any authentic American record up to that time. No one knows how far, in the hands of a more expert bowman, this Osage bow will shoot.

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[1] Address delivered on January 17, in Washington, D. C., before a meeting of the American Society of Landscape Architects.

The stump of this tree is still alive. At the arboretum we shall try to propagate and perpetuate it, by cuttings or by grafting, and if we can find another Osage tree of equal superiority we will crossbreed the two and develop a whole population of these tree aristocrats. One can not foretell the possible industrial uses of such a wood. It is suggested, however, by way of warning, that if golf sticks are ever made from the Rockville Osage, it may become necessary for golf clubs to double the length of their holes.

The search for superior trees of every kind and the making of experiments with them will occupy, undoubtedly, a large part of the arboretum's activities in future years. The beautification of American homes and the beautification of parks for purposes of outdoor relaxation and recreation is dependent largely on trees. Every one knows the beauty of the Japanese flowering cherries in Potomac Park. Even in Japan, last spring, I saw no more impressive display of cherry blossoms than is afforded by the mile stretch of Yoshino cherries around the borders of our Tidal Basin, that most gracious gift from the City of Tokyo.

These Japanese cherries have set us thinking about the little-appreciated beauty of some of our own wild trees. Two or three years ago I suggested to Colonel Grant the desirability of preparing for our public parks an extensive display of our American sweet-scented wild crab. This is the tree that the good Lord evidently intended for our national flower, but we have been slow to appreciate the divine gift and to provide for it the place of honor it deserves. Our wild crabs are of several species. They extend from New York to Minnesota and southward to Florida and Louisiana, and they are beloved by all who know them. At the National Arboretum we not only shall give them a place of honor, but we shall select the most outstanding individuals among them, and these we will cross-breed, making selections again among the progeny until we have developed a wide range of varieties, more beautiful even than the wild trees and more fully adapted to the purposes of landscape art. I can not believe, however, that we shall ever develop a cultivated crab more fragrant than the wild ones.

For some reason which is unexplained, Providence did not allow the wild crab to enter New England, the home of our early poets. In consequence its beauty and its fragrance long remained unsung, but ask the man from Des Moines or from Tallahassee if he knows the wild crab, and you will get a new lesson in the appreciation of nature.

Although many of the botanical experiments and discoveries made at the arboretum will be of value chiefly to horticulture and to landscape art, the most important work of the arboretum will find its application in forestry. In a recent address in New York, before the Garden Club of America, I made a statement which I may be permitted to repeat here:

> It is well known to American foresters that our original stands of timber are fast disappearing. White pine is already gone. At the present rate of cutting, the original stand of southern longleaf pine is expected to last eight years. The irregular process of natural reseeding will replace, ultimately, some of the timber that we have cut. We shall be compelled, however, before long to grow trees as a crop, just as we grow corn or wheat or potatoes. When we begin to plant trees as a timber crop, should we plant wild seedlings or should we plant improved strains, just as we now plant improved strains of corn, wheat and potatoes? There can be but one answer. When we go to the expense of growing trees as a crop we shall plant improved kinds just as soon as we have the improved kinds to plant. It is the primary function of the National Arboretum to

develop improved kinds of timber trees, by selection, by hybridization and by comparative tests of wild seed, selected seed and hybrid seed. We have every confidence in the outcome of such research and experimentation, for the tree is only a plant and that kind of experiment has succeeded with every other plant to which it has been scientifically applied. A white pine so improved in its rate of growth that it will reach in fifty years or in sixty years the size that now requires eighty years would repay the cost of the National Arboretum for a generation.

The members of the American Society of Landscape Architects here present may with propriety be asking for what purpose is this address delivered before this society, for although much has been said about the relation of the arboretum to forestry and to horticulture, little has been said about its relation to landscape art. I must confess that at the present time I am chiefly concerned not with what the National Arboretum can do for landscape art but with what landscape art can do for the National Arboretum.

The arboretum is still in the land-purchase stage. Its actual operation has not yet begun. The secretary of agriculture has purchased, or is in process of purchasing, 268 acres. He expects to make additional purchases which, with other land already owned or claimed by the government, will make a total of approximately the thousand acres originally planned for the arboretum. The site contains several elements of great dignity and beauty: Mount Hamilton, covered with a growth of mature hardwood timber and overlooking the city, with an excellent view of the Capitol, the Washington Monument and the Arlington hills in Virginia; Hickey Hill, with fine views up the Anacostia River and down it to the Potomac; the curve of the upper Anacostia, bordered with wild-rice and sweeping around to the old deer lick at Licking Banks, and the waterlily gardens at Kenilworth, one of the most beautiful sights in the city of Washington.

The National Arboretum is to be an outdoor laboratory for scientific research on trees. The materials for research are the trees and shrubs that will be planted in the area. It is planned to bring there every kind of tree that will thrive out of doors under this climate. There will be buildings, greenhouses and nurseries. Broad highways will border the arboretum, and it is expected that one of the principal entrances to Washington will pass through it. The parts of the arboretum in contact with these principal streets, or in view from them, should be developed with all the natural beauty that the situation affords. The greenhouses, the nurseries, the experimental plantings in straight lines and the every-day work with spades and hoes should be secluded from the main highways.

In the development of the National Arboretum the secretary of agriculture already has the hearty cooperation of the Garden Club of America, the American Association of Nurserymen and many scientific organizations. He would greatly appreciate the cooperation and advice of the American Society of Landscape Architects.

OBITUARY

JULIUS BUEL WEEMS

Dr. Julius B. Weems, chief chemist of the Agricultural Department of the State of Virginia, died suddenly on Saturday morning, January 25, at his home in Ashland, Virginia.

Dr. Weems had been with the state for fifteen years and was widely known as a chemist. His contributions to scientific journals, in the form of articles on agricultural and chemical problems, added to the reputation which he had as a consulting and analytical chemist, and a student of farm questions before he came to the Department of Agriculture.

He was born in Baltimore, August 27, 1865, the son of Edwin Dawson Weems and Rosetta Norman Weems. Following his graduation from Maryland Agricultural College in 1888, he studied at Johns Hopkins University for two years. In 1894, while a fellow in chemistry at Clark University, he received his degree of Doctor of Philosophy. For the next ten years he was professor of agricultural chemistry and chemist of the experimental station at Iowa College.

Dr. Weems was a member of the Society of American Bacteriologists, the American Chemical Society, and a fellow of the American Association for the Advancement of Science.

W. C. J.

AUGUST TOBLER

The death is announced on November 23 of Dr. August Tobler, the director of the Geological Section of the Natural History Museum, Basel, Switzerland. Dr. Tobler was a geologist of international reputation. He did much work in the Netherlands East Indies, his principal publication on that region being "Djambi-Verslag," which consists of a volume of 585 pages of text and 19 plates and an atlas of 9 geological maps, structure sections and a table of the different geological formations. Dr. Tobler also made studies of the geology and paleontology of northern South America, especially Venezuela and Peru. The high quality of Dr. Tobler's work is recognized by every one familiar with it. Besides the respect due him because of his scientific attainments, he endeared himself to his scientific colleagues by the help that he was ever ready to render them in their investigations. His death causes a severe scientific loss and removes a personality which had extended its kindly influence to all the continents.

T. W. V.

KAMAKICHI KISHINOUYE

DR. KAMAKICHI KISHINOUYE, professor emeritus of fisheries in the faculty of agriculture in Tokyo Imperial University, died on November 22, 1929, at Chengtu, Province of Szechuan, China, while collecting fresh-water fishes in the upper part of the Yangtze-Kiang. He started from Tokyo last August on an expedition to collect fishes along the Yangtze-Kiang and had been successful in obtaining much material, but was attacked with some alimentary disorder and died on November 22.

Professor Kishinouye was in several lines of work one of the leading scientific men of Japan. He published a number of papers on the Alcyonarian corals, paying special attention to those that produce coral of commercial value. He studied numerous problems of the life history of Japanese fishes and was especially well known for his investigations of the scombroid (mackerel) group. He was the author of a volume entitled "Contributions to the Comparative Study of the So-called Scombroid Fishes," published in the *Journal* of the College of Agriculture of the Imperial University of Tokyo, Volume 8, No. 3, 1923.

Professor Kishinouye attained high scientific recognition in his native country, being a member of the Imperial Academy of Sciences. Besides being a man of scientific distinction he possessed great personal charm and was a good example of the courteous Japanese gentleman of the old school.

T. W. V.

RECENT DEATHS

DR. LEA MCILVAINE LUQUER, tutor and associate professor of mineralogy at Columbia University from 1887 to 1925, died on January 30, at the age of sixty-four years.

DR. J. FRED MOHLER, for thirty-three years professor of physics at Dickinson College, died on January 28 at the age of sixty-five years.

WILLIAM WALLER CARSON, professor emeritus of civil engineering at the University of Tennessee, died on February 7, at the age of eighty-four years.

DR. THORBURN BRAILSFORD ROBERTSON, professor of physiology and biochemistry at the University of Adelaide, died on January 27 at the age of forty-five years.

SIR GEORGE DANCER THANE, the British anatomist, died on January 14 at the age of seventy-nine years.

DR. YOSHIAKI OZAWA, professor of paleontology at the Imperial University of Tokyo, died on December 29. Dr. Ozawa had returned to his work in Japan this last summer after two years of foreign study in Europe and the United States.

DR. BENEDIKT DYBOWSKI, professor of zoology at Lwow University, died on February 1, at the age of ninety-five years. After being exiled to Siberia for participating in the 1863 insurrection in Poland he undertook a study of fauna from Lake Baikal to Kamchatka.

SCIENTIFIC EVENTS

AGRICULTURE IN THE BRITISH EMPIRE

THE nineteenth annual report of the British Development Commissioners for the year ended March 31, 1929, deals, according to a report in the London *Times*, with a large range of questions affecting agriculture, rural economy, fisheries and harbors, the compulsory acquisition of land for road improvement, and the financial position of the development fund.

The total advances from the development fund recommended during the year amounted to £394,752, compared with £383,652 in 1927–28. The administrative expenses of the commission amounted to £9,315, compared with £9,887 in the preceding year.

Since the commissioners' last report eight bureaus have been established in accordance with the recommendation of the Imperial Agricultural Research Conference in 1927. Their purpose is to collect and disseminate information of a scientific character on various branches of agricultural research. Their establishment so soon after the meeting of the conference is a matter for congratulation, the commissioners remark, because of the assistance they will give to scientific workers in different countries. But the benefit to individual and isolated workers is not the only reason for which the bureaus are welcomed. Since they are the result of joint action taken by a number of empire governments, will be controlled by a representative empire committee, and financed by empire contributions, the bureaus are to be welcomed as a first—and it is to be hoped only a first—step in a policy of cooperation by the governments of the empire for the promotion of agriculture by enlisting scientific aid.

It is estimated that £22,000 per annum will be required to maintain the bureaus, and this sum is being raised by proportionate contributions. The contribution of England and Wales has been assessed at £3,125, and that of Scotland at £500. The commissioners have recommended payment of these home contributions from the development fund, in view of the advantages which British agricultural investigators will derive from participation in the scheme.

While it is unquestioned, the commissioners add, that advantages will accrue to agricultural science in this country from the creation of the bureaus, it is anticipated that still greater advantages will be derived from them by oversea workers. It is not only because of the dominating position which agriculture holds in the national economy of oversea countries that their representatives pressed for the bureaus. If this had been the main reason the proposal would have been made many years ago; for in some countries at least the need of a central organization has long been recognized. The immediate cause of the demand made at the conference was the clear realization by empire workers that the mother country is now in a position to offer them substantial aid. The institutions which have been built up as a result of the creation of the development fund in 1909 are taking a leading place in the application of scientific research to agriculture and Britain can offer, as twenty years ago it could not, much valuable guidance for those attempting to improve agricultural practice in the oversea empire.

CARNEGIE-AUSTRALIAN-HARVARD EXPEDITION TO NORTHWESTERN AUSTRALIA

UNDER the combined auspices of the Carnegie Institution of Washington, which made the original grant, the Australian National Research Council, which made a generous supplementary grant, and the Museum of Comparative Zoology, Harvard University, Professor Hubert Lyman Clark, of the museum, has just completed an important investigation of the echinoderm fauna of the northern and western coasts of Australia. Leaving Cambridge in the spring, accompanied by Mrs. Clark, who has served as artist and general assistant, Dr. Clark attended the Pan-Pacific Scientific Congress in Java in May, as delegate from Harvard University and the American Society of Naturalists. After three weeks in Java, he and Mrs. Clark went to Darwin, N. T., where they arrived on June 13 and a few days later were joined by Mr. Arthur A. Livingstone, of the Australian Museum, who continued with them until the party reached Perth, a most willing, competent and congenial assistant.

At Darwin the collecting was poor, especially along shore, owing to the large amount of sediment in the water which tends to form a muddy deposit wherever it is not kept scoured off by tidal currents. During the more than six weeks spent at Darwin only sixty-five species of echinoderms were found, though excursions to points from six to thirty-five miles distant were undertaken. Of the sixty-five species, not a dozen could be called at all common. On July 29 the party left Darwin and went to Broome, W. A., with brief stops at Wyndham and Derby on the way. These stops were long enough to show that local conditions at those ports were even more unfavorable for echinoderms than at Darwin, owing to the muddy water. At Broome, however, where two months were spent, the water is ordinarily very clear and marine life is extremely abundant. As local conditions are very varied and the tidal range very great (up to thirty feet and even more), Broome is a paradise for the marine zoologist. As the pearl-shell fishery is the one essential occupation, the local boats with their divers provide an unusual and important means of securing zoological material. Excursions were made from Broome, to Cape Levéque lighthouse, 142 miles to the northeast, and to La Grange Bay, Anna Plains and Wallal, 150 miles to the southwest. Altogether more than 170 species of echinoderms were secured in this region, many of which are apparently as yet undescribed.

On October 1 the party left Broome for Perth. There was a short stop at Onslow which yielded nothing and a day at Geraldton which yielded a few interesting species. At Perth, a stay of nearly three weeks, with important excursions to Rottnest Island and Bunbury proved most rewarding. The cooperation of the museum, university and government officials was generous and helpful to the last degree. Similar but briefer stops were made at Adelaide, Melbourne, Hobart, Sydney and Brisbane, and at all these places the courtesies extended knew no limits and the cordial cooperation shown was overwhelming. At Adelaide and Melbourne opportunities were given for examining both in the field and in the museums many of the fossil echinoderms of Australia, chiefly Tertiary. The cooperation of the Australian Museum at Sydney has been constant and most cordial during the whole investigation. Nothing has been left undone by Australian scientists which could further Dr. Clark's researches in any way. As a result of this hearty cooperation, it has been possible to study in life, under normal environmental conditions, some three hundred species of Australian echinoderms, about three fourths of which were seen on the northwestern coasts of the continent, a region hitherto a *terra incognita* to the marine zoologist.

THE GEORGE WILLIS PACK FORESTRY FOUNDATION OF THE UNIVERSITY OF MICHIGAN

THE promotion of practical forest land management in the broadest sense of the term is the object of a gift of $200,000 made by Charles Lathrop Pack, of Lakewood, New Jersey, to the University of Michigan. This fund is to be known as the George Willis Pack Forestry Foundation in memory of the donor's father, and the income from it will be used by the school of forestry and conservation in carrying out the purpose of the foundation.

In establishing the foundation, Mr. Pack stated that the school of forestry and conservation was chosen as the medium through which to carry out his plans for the advancement of forestry in this field "on account of its prestige, its facilities for teaching the broad principles of all phases of practical forestry and its experienced staff."

The income from the foundation is to be used for the salary and expenses of an experienced forester to be known as the George Willis Pack professor of forest land management, and for such other expenditures as may be necessary in carrying out the purposes of the foundation. In accordance with the wishes of the donor, who is keenly interested in the practical application of forestry, it is expected that the holder of this professorship will devote the larger part of his time to furthering the practice of forestry in the woods rather than in the classroom. He may, however, assist in the instructional activities of the school, and will doubtless work particularly with graduate students. He will be expected to spend considerable time in travel in order to keep in close touch with forest conditions and practices in other parts of the country and to make the results of his experience as widely available as possible.

In commenting upon the gift, Dean Samuel T. Dana, of the school of forestry and conservation, stated that the income from the George Willis Pack Forestry Foundation will be used, in accordance with Mr. Pack's wishes, for two major purposes—to develop the wild land properties owned by the university, and to cooperate with forest land owners in bringing about the practice of forestry and more profitable methods of forest management of privately owned lands. "The University of Michigan," said Dean Dana, "has three small areas of forest land in the vicinity of Ann Arbor, which are used both as outdoor laboratories for the instruction of students and for investigative purposes, and which are already under careful management. In addition to these, the university owns approximately 6,300 acres of wild lands in the northern part of the state."

In making his gift, Mr. Pack pointed out that the Biological Station at Douglas Lake in Cheboygan County contains some 3,300 acres on which forestry measures can advantageously be undertaken to supplement the work already under way by the zoologists and botanists at the station. Situated within a few miles of the city of Cheboygan and in the immediate vicinity of several summer camps and serving as headquarters for the biological station with a summer attendance of approximately one hundred students from all parts of the country, it is particularly well located for demonstration purposes.

Excellent opportunities for forest management are also offered by the Chase S. Osborn Preserve on Sugar Island in the St. Mary's River, presented to the university last fall by Ex-Governor Osborn. This tract of some 3,000 acres was burned perhaps fifty years ago and is now covered with a well-stocked second growth consisting of a wide variety of both hard and soft woods.

GIFTS TO THE SCHOOL OF FORESTRY OF YALE UNIVERSITY

YALE UNIVERSITY has announced three new gifts to the School of Forestry to be devoted to education, experiment and demonstration in applied forestry. The Charles Lathrop Pack Foundation given last year by Mr. Charles Lathrop Pack, of Lakewood, New Jersey, has been increased to $325,000. A gift of $100,000 to endowment has been received from Mr. and Mrs. Starling W. Childs, of New York. Mr. George Hewitt Myers, of Washington, is transferring to the school a tract of forest land in Tolland and Windham Counties, Connecticut, aggregating in area nearly 8,000 acres. These gifts, all closely related in purpose, constitute a new project, supplementing and greatly strengthening the work and facilities of the school of forestry in instruction and in advancing the knowledge and practice of forestry. Announcement is also made of the appointment of Mr. Nathan D. Canterbury, formerly State Forester of Louisiana, as director of the new Yale Forest, on the Charles Lathrop Pack Foundation.

According to Dean Henry S. Graves:

> The new gifts will enable the school of forestry to extend its field activities, both in connection with the training of students and in providing demonstrations of practical forest management. The new forest is large enough for a practical operating unit and for the demonstration of all the various activities involved in the management of a wooded estate of this size and character. Protection from fire, maintenance of roads, trails and other improvements, cutting of timber under skilful methods, forest planting, marketing of forest products, administration of wild life and many other features of applied forest management will be demonstrated at the Yale Forest. The undertaking will give special emphasis to the training of students and experimentalism in applied forestry; it provides also for owners of forest estates to see the practical results of forestry.

The forest is located in the towns of Union, Ashford, Eastford and Woodstock, in northeastern Connecticut. It has been protected for many years and is well stocked with hard woods, pine and hemlock. There is enough merchantable timber to permit economic forestry operations at once. The educational phases of the work on the forest will be progressively developed, as the details of administration of the property are perfected.

The director of the forest, Mr. N. D. Canterbury, graduated from the Yale School of Forestry in 1922. He has been associated with various enterprises, both in business and in public service.

THE CHILEAN NITRATE OF SODA NITROGEN RESEARCH AWARD

ABOUT two years ago the Chilean Nitrate of Soda Educational Bureau of New York made available an annual appropriation of $5,000 to be distributed in the form of one or more prizes for outstanding research in this country and Canada on nitrogen in its relation to soil processes and plant growth. The above sum has been placed in the hands of the American Society of Agronomy, the award being administered by a special committee of the society.

The first awards were made in 1928. The committee held then that it was advisable to select older investigators whose previous work in advancing knowledge of nitrogen in relation to plant growth has been beyond question. Professor J. G. Lipman, director of the New Jersey Agricultural Experiment Station, Professor T. L. Lyon, chief of the soil department, Cornell University, Professor E. B. Fred, division of agricultural bacteriology, University of Wisconsin, and Professor F. T. Shutt, dominion chemist, Ottawa, Canada, were those selected. In connection with the announcement of the selections for 1928 the committee suggested that subsequently it would be appropriate to consider and perhaps even give preference to those younger investigators who have made recent contributions to the subject.

The second award, announced at the 1929 meeting of the society, was divided among three investigators, namely, Professor C. A. Mooers, director of the Tennessee Agricultural Experiment Station; Professor P. L. Gainey, soil bacteriologist of the Kansas Agricultural Experiment Station, and Professor S. A. Waksman, microbiologist of the New Jersey Agricultural Experiment Station.

In order to make clear the nature of the investigations that will be considered for the award in 1930 the committee feels that it is desirable to publish a brief statement at this time.

Investigations will be considered which deal with the physical, chemical or microbiological transformation of both organic and inorganic nitrogen in the soil, the absorption and utilization of nitrogen by plants and nitrogen fertilizer in any of its aspects. The committee will give particular attention to those contributions which have been published within the past year or two. Investigations of longer standing will also be considered provided the authors are still actively engaged in the work.

Investigations dealing with any phase of nitrogen in relation to soils and crops may be called to the attention of the committee either by an author himself or by any one else. The award, which may be made either to one or more investigators, will be recommended to the society, according to the judgment of the committee.

The committee takes this opportunity to solicit nominations of candidates for the 1930 award. The nominations should be made in writing and may be addressed to any member of the committee. Although it may be difficult to select the "most" outstanding contribution to such a complex subject as nitrogen in its relation to soils and plants, the committee hopes that it will at least be able to select one or more investigators who have made a notable contribution to the scientific understanding of the rôle of nitrogen in soils and plants. It is expected that the award will be used in such a way as to lead to still higher scientific activity.

The award is open to investigators irrespective of their connection with the American Society of Agronomy. The investigation may have been made at a university, state experiment station, government institution or privately.

R. W. THATCHER,
C. B. WILLIAMS,
W. P. KELLEY,
R. I. THROCKMORTON,
R. BRADFIELD,
S. A. WAKSMAN, *Chairman*
Chilean Nitrate of Soda Nitrogen Research Award Committee

SCIENTIFIC NOTES AND NEWS

A BRONZE memorial plaque, picturing Mr. and Mrs. Thomas A. Edison, was unveiled at Fort Myers, Florida, on February 11, in celebration of Mr. Edison's eighty-third birthday. The plaque was erected in the city park by a committee of civic workers and will be illuminated perpetually.

DR. W. M. DAVIS, emeritus professor of geology at Harvard University, celebrated his eightieth birthday on February 12 at Tucson, Arizona, where and in California he has been actively engaged in geological work.

At a meeting of British botanists in London, held to receive the report of the executive committee on the progress which has been made in organizing the International Botanical Congress, which will be held in Cambridge from August 6 to 19 under the presidency of Professor A. C. Seward, a message of congratulation was sent to Dr. Sydney Howard Vines, F.R.S., Sherardian professor of botany in the University of Oxford, and fellow of Magdalen College from 1888 to 1919, who celebrated his eightieth birthday on December 31.

Dr. Irving Langmuir, associate director of the research laboratory of the General Electric Company, has been awarded the Willard Gibbs Gold Medal of the Chicago Section of the American Chemical Society for 1930, for "fundamental work on atomic hydrogen and on surface relations and also on electrical discharge phenomena. Also for his contributions of great importance to nearly all branches of physical chemistry, including high vacuum technique, electronics, thermochemistry and catalysis. And lastly for his presentation of a theory of atomic structure."

The presentation of the American Iron and Steel Institute Medal awarded in October to Dr. Elmer A. Sperry, president of the Sperry Gyroscope Company, was made at a meeting of the board of directors at the Metropolitan Club on January 31. The medal, which was founded by the institute in memory of its founder and first president, Elbert H. Gary, was awarded for the first time to Dr. Sperry especially for his work on the non-destructive detection of flaws in steel rails. Mr. Charles M. Schwab, chairman of the board of the Bethlehem Steel Corporation and president of the institute, made the presentation.

At the annual general meeting of the Royal Meteorological Society on January 15, Sir Richard Gregory, the president, presented Dr. G. C. Simpson, director of the Meteorological Office, with the Symons's Gold Medal, in recognition of the value to meteorology of Dr. Simpson's researches on thunder-storms and terrestrial radiation.

A bronze *bas relief* of Dr. C. H. Kauffman, professor of botany and director of the herbarium, was presented to the University of Michigan on January 24. It is the gift of twenty-eight doctorate students of Dr. Kauffman, which group includes those who have taken the degree of doctor of philosophy and those who are at present working under him. The plaque was made by Mr. Carleton W. Angell, of the University of Michigan, and it was sent to Munich, Germany, to be cast in bronze. Dr. G. Carl Huber, dean of the Graduate School, presented the portrait to the university, and it was accepted by President Alexander G. Ruthven. It will be placed in the herbarium library in the museums building.

Dr. Samuel Theobald, clinical professor emeritus of ophthalmology in the Johns Hopkins University School of Medicine, was honored by the ophthalmologic section of the Baltimore City Medical Society on January 23, the fiftieth anniversary of his discovery of the use of boric acid in direct application to the eye.

Dr. H. S. Fawcett, professor of plant pathology in the Citrus Experiment Station of the University of California, was elected president of the American Phytopathological Society at the recent Des Moines meeting.

Derwent Whittlesey, assistant professor of geography at Harvard University, has been appointed editor of the *Annals* of the Association of American Geographers.

Professor Arthur C. Hardy, of the department of physics of the Massachusetts Institute of Technology, has been chosen by the Society of Motion Picture Engineers to be chairman of its committee on standards. This committee will consider the proposed increase in the width of motion-picture film. The standard film is thirty-five millimeters wide. With the advent of the talking motion picture it was necessary to use about one tenth of an inch from one side of the film for the "sound track," thus narrowing the space available for the picture area. Recently films of widths ranging from fifty to seventy millimeters have been proposed and some experimental pictures have been shown. The object of wider films is to permit the projection of pictures of full stage dimensions.

Dr. A. A. Levine, who for the past six and a half years has been on the staff of the department of chemistry of the State College of Washington, has resigned to accept a research position with the Roessler and Hasslacher Chemical Company, of Niagara Falls, New York. He is being succeeded by Dr. W. E. Bradt, who for the past two and a half years has been on the teaching and research staff of the department of chemistry of the University of Cincinnati. Dr. Bradt received his bachelor's, master's and doctor's degrees from Indiana University.

Dr. C. E. Resser has been appointed curator of stratigraphic paleontology in the National Museum. He has been connected with the division of paleontology since 1915.

DR. N. ERNEST DORSEY, having completed his work as associate editor of "The International Critical Tables," has returned to the Bureau of Standards.

DR. WILLIAM B. MCDOUGALL, of the University of Illinois, has been appointed visiting professor of botany at the University of Southern California for the spring semester. He will fill the vacancy in the department of botany during the sabbatical leave of Professor Howard de Forest.

DR. HUGH CABOT, dean of the Medical School of the University of Michigan, has been relieved of his duties of that office and as director of the department of surgery. He continues as professor of surgery. The action has been taken owing to differences in questions of policy between Dr. Cabot and the faculty.

DR. CLARENCE C. LITTLE, formerly president of the University of Michigan, will act as director of the Mount Desert Island Biological Laboratory at Salisbury Cove for the coming six months during the absence of Dr. Herbert V. Neal, professor of zoology at Tufts College, who has gone on a scientific expedition to the Nile Valley. Dr. Little is at present director of the Dorr Station of the laboratory as well as director of the Roscoe B. Jackson Memorial Laboratory for Cancer Research.

PROFESSORS EDWIN O. JORDAN and William H. Taliaferro, of the department of hygiene and bacteriology of the University of Chicago, are spending the winter quarter at the School of Tropical Medicine, San Juan, Porto Rico. Professor Hans Smetana, of the University of Vienna, formerly of the Johns Hopkins Medical School and the Peking Union Medical College, has become assistant professor of pathology at the school, holding dual appointments in Columbia University and the University of Porto Rico. Professor George W. Bachman, formerly of the School of Hygiene and Public Health of the Johns Hopkins University, has accepted the post of associate professor of parasitology in Columbia University with duties at the School of Tropical Medicine.

PROFESSOR S. HATAI, of Tohoku Imperial University, Sendai, Japan, has extended an invitation to Professor Charles A. Kofoid, of the University of California, to be visiting professor of biology on the Rockefeller grant. Professor and Mrs. Kofoid sail on March 14 for a period of three months of lectures at the Biological Institute at Sendai and three months at the Marine Biological Station at Asamushi, at the northern end of Hondo, for graduate instruction and research.

MR. MATTHEW W. STIRLING, chief of the Bureau of American Ethnology, left Washington on January 13 for a cruise among the Ten Thousand Islands between Charlotte Harbor and Cape Sable, Florida, where he hopes to discover evidences of the former occupancy of this area by the Caloosa Indians. He is being aided by Mr. Lee Parish, of Tulsa, Oklahoma, whose 85-foot yacht, *Esperanza*, furnishes transportation. After his exploration in the Ten Thousand Islands region Mr. Stirling will excavate a large sand mound on the west coast of Florida, south of Tampa Bay.

C. B. PHILIP, associate entomologist for the Rocky Mountain Spotted Fever Laboratory of the U. S. Public Health Service at Hamilton, Montana, has returned from a tour of eighteen months in West Africa, as entomologist of the Yellow Fever Commission of the Rockefeller Foundation.

MR. M. F. BRAMLEY, of Cleveland, Ohio, has invited the Cleveland Museum of Natural History to send two men with him on a short entomological trip into Central America. The museum secured Dr. George P. Engelhardt, director of natural sciences in the Brooklyn Museum, to make this trip, along with their own entomologist, Mr. John C. Pallister. The party left Long Beach, California, on February 1, in Mr. Bramley's yacht, *The Peary*. This is the yacht used by MacMillan and Byrd on their Arctic expedition. Before going to Guatemala the party will spend a few days on the uninhabited island of Socorro.

DR. H. M. DADOURIAN, professor of mathematics and astronomy at Trinity College, Hartford, Connecticut, has leave of absence. With Mrs. Dadourian he expects to travel in the Near East and Europe, including Russia, returning at the end of September.

PROFESSOR F. A. MELTON, of the department of geology of the University of Oklahoma, will spend seven months from February to September in research work and study in southern and central Europe on the relationship of jointing to orogeny.

DR. PHILIP E. SMITH, professor of anatomy in the College of Physicians and Surgeons of Columbia University, will deliver the fifth Harvey Society lecture at the New York Academy of Medicine on February 20. His subject will be "Relations of the Activity of the Pituitary and Thyroid Glands."

DR. W. F. G. SWANN, director of the Bartol Research Foundation of the Franklin Institute, Philadelphia, recently delivered a lecture before the Royal Canadian Institute on "Philosophical Aspects of Modern Physics."

DR. OSCAR RIDDLE, of the Carnegie Institution, addressed the Commonwealth Club and the University Club of Chicago on January 24 and 25 on "Disclosing Mechanisms of Life."

PROFESSOR V. K. LA MER, of Columbia University, delivered two lectures before the department of chemistry of Brown University on January 10 entitled "Solutions of Electrolytes" and "An Extension of the Debye-Huckel Theory to High Valence Ions in Nonaqueous Solutions." Professor La Mer gave the same lectures before the departments of chemistry of the Universities of Wisconsin, Iowa, Nebraska, Kansas and Illinois and the Iowa State College at Ames.

DR. EDWARD FRANCIS, of the U. S. Public Health Service, will give two lectures under the Harrington Foundation at the University of Buffalo Medical School. The first will be on "Tularemia" on February 27, the second on "Undulant Fever" on February 28.

PROFESSOR ROBERT H. GAULT, of Northwestern University, read a paper before the Franklin Institute on the evening of January 30, entitled: "A Partial Analysis of the Effects of Dual Stimulation from Spoken Language."

PROFESSOR FRANCIS E. LLOYD, of McGill University, Montreal, delivered lectures on January 28 and 29 at Ann Arbor and Detroit. At the University of Michigan his subjects were "A Botanist's Tour in Africa" and "The Comparative Morphology and Physiology of the Bladders of Utricularia." In Detroit he spoke under the auspices of the United States Rubber Company on the "Culture of Plantation Rubber."

DR. FRIDTJOF NANSEN will lecture in London on "The Importance of Meteorological Research" on March 14 before a joint meeting at the Institution of Electrical Engineers of the Royal Aeronautical Society and the Royal Meteorological Society.

THE program of the non-biological science section of the Ohio State University Educational Conference on April 4, which will be presided over by Professor Wm. Lloyd Evans, is as follows: "Matter and Energy," Professor Alpheus W. Smith, the department of physics, the Ohio State University; "Symmetrical and Unsymmetrical Hydrogen," Professor Herrick L. Johnston, the department of chemistry, the Ohio State University; "An Interpretation of the New Mechanics," Dr. Saul Dushman, the research laboratory, the General Electric Company; "What are the Stars?" Professor H. T. Stetson, the department of astronomy, the Ohio Wesleyan University; "Some Applications of the New Mechanics to Physics and Chemistry," Dr. Saul Dushman; "What is Light?" Professor Arthur H. Compton, the department of physics, the University of Chicago.

PRESIDENT J. Y. SNIDER, of the American Association of Petroleum Geologists, in a letter addressed to the chairman of the section of geology and geography of the American Association for the Advancement of Science, extends a cordial invitation to all association members to attend the annual convention of the petroleum geologists to be held in New Orleans on March 20, 21 and 22, with headquarters at the Roosevelt Hotel. Those interested may obtain further information concerning this meeting by addressing J. P. D. Hull, Box 1852, Tulsa, Oklahoma.

DR. J. MURRAY LUCK, secretary of the Pacific Division of the American Association for the Advancement of Science, writes that at the thirteenth annual meeting of the division announcement was made that a prize of $100 would be awarded to the authors of the most important scientific contribution reported at the Berkeley meeting. The amount of the prize was increased by recent action of the executive committee to $150. Five papers were submitted to the committee on award as being worthy of consideration. Acting on recommendations received, the executive committee at its last meeting awarded the prize to the investigations on the isotopes of oxygen pursued by W. F. Giauque and H. L. Johnston, of the University of California, and H. D. Babcock, of the Mount Wilson Observatory. In this work convincing evidence was presented of the existence in small proportions of two isotopes of oxygen, masses seventeen and eighteen. The committee also acknowledged the unselfish services of Professor R. T. Birge, an international expert in matters relevant to the study of spectral lines, whose contributions were of invaluable assistance in bringing these investigations to a successful conclusion. Honorable mention was made of the contribution by E. B. Babcock and J. L. Collins, of the University of California, on the "Rate of Mutation in *Drosophila melanogaster* as Affected by Differences in Earth Radiation."

The University of Texas has recently come into possession of somewhat more than $800,000 bequeathed to it by the late W. J. McDonald, of Paris, Texas, for erecting, equipping and maintaining an astronomical observatory. The bequest was contested by relatives and the amount mentioned above is the result of a compromised suit. The university will proceed very carefully and slowly to plan for the future McDonald Astronomical Observatory, availing itself of the advice of the most competent astronomers.

H. R. FRY has given an eight-inch refracting equatorial telescope to the University of London Observatory in Mill Hill Park, which is administered by University College.

THE Research Corporation of New York has appropriated $15,000 for the work of the division of radiation and organisms of the Smithsonian Institution.

The *Journal* of the American Medical Association reports that during the twelfth International Ophthalmological Congress, I. Van der Hoeve, president of the congress, and E. Marx, secretary, called a meeting at which the representatives of the following states and cities were present: Van der Hoeve, Leyden; Jitta and F. Wibaut, Amsterdam; Angelucci and V. Rossi, Naples; Lutrario, Rome; Emile de Grosz, Budapest; Auerbach, Moscow; F. Avizonis, Lithuania; F. H. Beaumont, New Zealand; Birch-Hirschfeld, Königsberg; Coppez, Brussels; A. Feigenbaum, Jerusalem; Gray Clegg, Manchester; Hamburg, Roumania; Hanke, Vienna; F. Humbert and Morax, Paris; Imre, Pécs; Lundsgaard, Copenhagen; Lussich-Matkovic, Zagreb; Marquez, Madrid; M. Nakashima and S. Myashita, Japan; J. Park Lewis, Buffalo; Walter R. Parker, Detroit; C. Pascheff, Sofia; Pavia, Buenos Aires; Soria, Barcelona; Symansky, Warsaw; Charles Weiss, United States; W. H. Wilder, Chicago; R. E. Wright, Madras; M. Zachert, Poland. The spread of trachoma and the necessity of the campaign against it were set forth in an exhaustive report by Lutrario and Jitta, delegates of the Comité d'hygiène of the League of Nations. It was resolved to form an international league, in accordance with the motion of Van der Hoeve. Dr. Emile de Grosz, professor of ophthalmology at the University of Budapest, was appointed president, and Dr. F. Wibaut, secretary. They were entrusted with the formation of a committee from among the delegates of the ophthalmic societies and leagues already existing. The president was authorized to communicate with the Comité d'hygiène of the League of Nations and the Rockefeller Foundation to endeavor to enlist their aid in the movement.

An extensive trip by the department of geology of Princeton University is being planned for next summer, when the party will make a journey of more than 10,000 miles throughout the United States. Under the leadership of Professor Richard M. Field, chairman of the department, an investigation of the principal natural resources of the United States and their relation to national and international trade and transportation will be made. Besides a number of American scientific men, the party will include representatives from Germany, England, France and probably Italy and Japan. Among these will be Dr. Hans Schneiderhohn, professor of economic geology at the University of Freiberg, and Dr. Harbort, lecturer in the Technische Hochschule, Berlin.

A gift of $50,000 to the Massachusetts Horticultural Society, by its president, Albert C. Burrage, was announced at the inaugural meeting of the society. Mr. Burrage stipulates that this gift is to be divided into two funds, one amounting to $30,000 and the other to $20,000. The income from the former is to be used to purchase books for the society's library, already recognized as the largest and best horticultural library in the world. The income from the second fund is to be used for a gold cup to be awarded at the end of each year for the best exhibit which has been made at any of the society's exhibitions in the course of that year. Another gift of $2,500 came from W. N. Craig, of Weymouth, to be used for the improvement of lilies.

DISCUSSION

BACTERIUM GRANULOSIS AND TRACHOMA

Two expeditions to Indian schools in the southwest for the purpose of confirming Dr. Noguchi's work on trachoma[1] were undertaken in May and September, 1929. The invaluable cooperation of Drs. F. I. Proctor, P. Richards and J. F. Lane in this work is hereby gratefully acknowledged.

Three types of cases have been examined: first, cases of undoubted trachoma in pupils who had been in school for some time and had received treatment in the usual way; second, similar cases which had received no treatment, and finally, untreated cases of recent onset. Noguchi's original isolations of *Bacterium granulosis*, on his expedition to the southwest in 1926, were obtained with advanced untreated cases, and our isolations have so far been obtained either from untreated cases or cases which had had no treatment for several months previous to culturing. However, it is probable that treated cases can be made to yield *Bacterium granulosis* by repeated bacteriological examination.

Our first expedition yielded two strains of *Bacterium granulosis* from two advanced untreated cases. Negative results were obtained in five advanced cases which were undergoing treatment and in three cases in which the diagnosis was uncertain. The cultures were made on horse blood agar and on the Noguchi semisolid leptospira medium and examined on our return to New York, nine days after their preparation.

Our second expedition yielded four strains, two from advanced cases, with abundant scar tissue, one from a case in which the formation of scar tissue was just beginning and one from a recent case in which no scar tissue was present. These four cases had received no treatment for six months previous to culturing. Eleven advanced cases undergoing treatment yielded no *Bacterium granulosis*, nor did six cases in which the diagnosis of trachoma was doubtful.

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[1] H. Noguchi, *J. Exper. Med.*, 48, Suppl. No. 2, 1928.

The strains of *Bacterium granulosis* obtained by us agreed culturally in all respects with the Noguchi bacterium. Two were tested individually in *Macacus rhesus,* both inducing the characteristic granular lesions of the conjunctiva. Three other strains isolated by us, when pooled and inoculated, produced in four of five monkeys typical experimental trachomatous lesions of marked severity, appearing first on the twelfth day and progressing to abundant development during the following six weeks.

E. B. TILDEN
J. R. TYLER

THE ROCKEFELLER INSTITUTE
FOR MEDICAL RESEARCH

THE PASSENGER PIGEON

IT is commonly believed that the passenger pigeon, so frequently seen through the middle west about fifty years ago, has ceased to exist on this continent. Several reports to the contrary have appeared from time to time, but it has usually been concluded by those in a position to know that these reports have concerned either the dove or the band-tailed pigeon from the west.

An article in the Detroit *News* for January 5 by Mr. Kendrick Kimball, staff correspondent of the *News*, reports some observations of interest made by Mr. Robert H. Wright, of Munissing, Michigan (Upper Peninsula), and by Dr. Samuel R. Landes, of Traverse City. The former is said to have observed a pair of passenger pigeons on highway M-28, about sixteen miles from Munissing, on June 10, 1929. They were in the road and he approached within ten feet of them—sufficiently close for him and his family to note the sheen on the neck and the red eyes. Dr. Landes, driving from Florida, observed a flock of about fifteen between Indianapolis and Kokomo. Both these men were said to be quite familiar with this species, having hunted and plucked hundreds of the birds in Michigan and Missouri, respectively, in the late seventies.

The article by Mr. Kimball has served as the incentive for me to report an observation made in the wilds of the North Peninsula of Michigan during the second week of September last.

An old friend, Mr. Foard, of Marquette, and myself were finishing a day devoted to running out lines of a tract of some six hundred acres of my summer camp on the north shore of Lake Huron, near Beaver Tail Point, about twelve miles east of Les Cheneaux. The country is wild, practically uninhabited, and lies mostly in "burnings" interspersed with patches of fresh growth of spruce, poplar and some old timber.

About six-thirty in the evening we were still some five miles from camp, pushing a line through the scrub and attempting to locate a trail. We had just paused to get our direction when Mr. Foard pointed to the top of a tall, dead white birch and said, "There's a passenger pigeon; I have seen several the last few years." I had to turn in order to look, and then the bird was already in flight, perhaps a hundred feet away. All that I could see was that it had the shape of a pigeon and a somewhat pointed tail. Mr. Foard had the better view and had seen the bird several moments before he spoke. While I can not therefore verify this report, I have great faith in Mr. Foard's powers of observation. His entire life has been spent in the woods of northern Michigan, as land agent and trespass agent for the government. Few in the state, I dare say, know more about the denizens of the Michigan woods than he. The deer, the bear, the timber-wolf and the birds have been his companions for forty years, and he knows them and their ways. As he told me when we continued our way homeward, discussing the strange disappearance of the passenger pigeon, he had often hunted the birds in the years around 1878 in this same country and knew them too well to be mistaken. Since their long disappearance he had seen none until quite recent times.

It seems to me that these three observations by Michigan men, all of whom knew the passenger pigeon in the old days, serve seriously to raise the question that has been propounded by Mr. Kimball in his newspaper article: "Has the passenger pigeon come back?" The northern peninsula of Michigan was once a famous nesting ground for this species, and it is hoped that the residents of this delightful region will continue to make special effort to recognize and report this assumedly extinct species whose sudden disappearance constitutes one of the greatest recent biological tragedies of the American continent.

PHILIP HADLEY

UNIVERSITY OF MICHIGAN

SEVERE HAIL INJURY TO TREES AND SHRUBS

ONE evening last summer, as the writer was returning home from a trip through southern Illinois, his attention was attracted by the peculiar appearance presented by the trees growing in a cemetery at the north edge of Marion, the county-seat of Williamson County, Illinois. As seen from the road, the foliage on practically all these trees appeared to be in crowded, rosette-like bunches on the larger limbs, while the small limbs were conspicuously dead and barren. It was almost dusk at the time, and as there were many miles yet to be driven, there was little inclination to tarry long enough to make a detailed examination of the trees. Later, however, on another trip to the locality, made on October 13, in company with Dr. Benjamin Koehler, crop pathologist at the

University of Illinois, a close examination was made of these trees and of the shrubs growing with them.

It was at once apparent that early in the season the trees had been stripped of their young developing foliage and small twigs and that the larger twigs and small limbs had been killed by some excessive injury. These stood out in the picture dead and barren against the greenness of a second growth of foliage and young twigs which, on all the trees, had since grown out very abundantly from a multitude of adventitious buds. The general aspect of these trees was such as to remind one of the war pictures of shrapnel-swept battlefields, where broken trees stand here and there denuded of their leaves after the bombardment. Truly these trees had been bombarded, for a terrific storm of hail had swept this area in the previous spring.

The numerous and markedly compacted bunches of new foliage, which from a distance appeared so much like rosettes, were generally abundant in all parts of the trees, in many cases even to the extent of growing out densely up and down the trunks, as if the trees, in a desperate effort to retain their hold on life, had made use of all their resources to reclothe themselves with leaves.

A close examination of the twigs and limbs of the trees, which were mostly maples and oaks, revealed severe hailstone lesions on the upper sides. These were frequently an inch or more long and often coalesced to form long compound lesions which, in many cases, resulted in a virtual girdling of the part.

From the many smaller branches and twigs which had been killed, in some cases for several season's growth back, by the excessive loss of cambium the bark was still peeling where it had not previously been stripped off by the hailstones.

The lesions on the still living twigs and small limbs were healing over very nicely with no sign of infection of any sort. The approaching layers of new tissue from the two sides of the long narrow lesions had, in the case of the smaller ones, already met, and in other instances, where the injury had extended half to three quarters of the circumference of the twig or limb, the healing process, although progressing very nicely, was not yet finished. The condition presented an excellent example of wound healing such as one is not often likely to meet with under ordinary circumstances.

On small ornamental junipers and Japanese barberry in the cemetery the foliage appeared normal, but a close examination of the twigs of these shrubs revealed severe hailstone lesions which, as in the case of the trees, were healing over very nicely.

Upon inquiry, the writer was informed by a local resident that on the first of May, 1929, a most severe hailstorm had occurred as a general disturbance over the entire locality but that the fall of hail had been exceedingly severe over the cemetery where, judging from the damage done, it had occurred in a path about two or three hundred yards wide from north to south. On neither side of this path did the vegetation show any such evidence of severe injury as was inflicted on the cemetery trees.

The hailstones were reported to be very large, almost the size of small hen's eggs. Automobile tops which were exposed to the storm were reduced to sieves by the bombardment. Hailstones of this size have occurred in Illinois before, although they have not been known by the writer previously to inflict such severe damage to trees. In the spring of 1927 particularly severe hailfall of very large stones occurred at Urbana and in the East St. Louis area as well as in St. Louis, Missouri, when great damage was done to houseroofs, greenhouses and automobile tops. At that time the Missouri Botanical Garden suffered severe damage to its greenhouses and to the very valuable plants contained in them.

GILBERT L. STOUT
ILLINOIS STATE NATURAL HISTORY
SURVEY

MAN-MADE EARTHQUAKES

ON October 18, 1929, between midnight and sunrise, slight earth tremors were felt at Big Springs and nearby towns in Texas. People were very generally awakened by the rattling of dishes and windows. One person at Big Springs states that he was awakened about 3 A. M. by what he thought at the time was an automobile hitting the house in which he was sleeping. Another says he was awakened at about this time thinking some one was rattling his door. At one place south of Stanton a lamp chimney was broken, and at another the glass in a door was fractured. Five or more distinct tremors were felt of which the last, occurring about daylight, was said by some to be the strongest. On the following night similar tremors were felt although apparently by fewer persons. Some who had lived in earthquake regions were positive that the tremors were earthquakes.

Inquiry made in the region affected indicated that the tremors were caused by explosions of dynamite made in connection with the use of the seismograph in geologic explorations. The company making these explorations very kindly supplied a record of seismograph shooting on October 17, 18 and 19, and this note is made to record the distance that such earth tremors from seismograph shooting may be transmitted under favorable conditions in sufficient force to attract general attention.

The record of the seismograph work indicated that on the forenoon of October 17, two shots were fired on Section 15, Block 36, T.4 S. At midnight shooting was resumed at this locality and eight shots were fired between 12:20 and 8:15 A. M., October 18. Charges of dynamite were used in the following order: 50, 300, 300, 900, 1,500 pounds, and 50, 300, 300, 900 and 1,800 pounds. The 1,500-pound shot fired at 3 A. M. on October 18 made the tremor which caused one person at Big Springs to think that an automobile had bumped his house and another to think that some one was rattling the door; the 1,800-pound shot fired at 6:15 A. M. coincides with the reports as to the strongest tremor felt. The shooting on the following night, October 18–19, was as follows. On Section 39, Block 36, T.3 S. from 9:25 to 11:30 P. M.: 50, 300, 300, 900, 1,500 pounds; from 12:50 to 3 A. M.: 50, 300, 300, 900, 1,500 pounds, and on Section 31, Block 35, T.3 S. from 3:50 to 5:55 A. M.: 50, 300, 300, 900, 1,500 pounds.

The 1,500-pound shot at 3 A. M. on October 19 seems to have been less generally felt than was the same charge at the same time on the previous night. All the shots were similarly placed, being covered by about five feet of earth. The temperature at 3 A. M. on October 18 was 14° C.; the wind velocity, 11.2; the direction of the wind, from 10 degrees east of north; the sky cloudy. On the next night the temperature at 3 A. M. was 18° C.; the wind velocity, 8; the wind direction, from 10 degrees east of south; the sky cloudy. The ground conditions at the locality of the shot which are not recorded in detail may account for the seemingly different intensity of the tremors. One or two observers at Knott report that the tremors of the second night were greater than those of the first. However, for the region as a whole those of the second night were not so generally felt or reported upon.

The shots of October 17 and 18 were made fourteen miles west of Garden City in Glasscock County. The tremors were felt at Sterling City forty-four miles east; at Big Springs thirty-two miles northeast; at Knott forty miles north; at Stanton twenty miles north, and at Midland twenty-one miles northwest. Inquiry among farmers and ranchmen indicated that even beyond the towns mentioned the tremors were more or less distinctly felt. Apparently the tremors were readily detected within a distance of forty or fifty miles east and north from the locality at which the dynamite was discharged, this being true at least for the larger shots of 1,500 and 1,800 pounds. The distance the tremors were felt west and south is less well known from lack of records. The surface formation at the locality where the dynamite was exploded and of much, but not all, of the country affected is Cretaceous limestone. Where the limestone is absent the surface formations consist of either Cretaceous sands or Triassic or Permian red sands and clays. The limestone is apparently an effective medium for the transfer of earth tremors.

E. H. SELLARDS

UNIVERSITY OF TEXAS

IN AID OF AMERICAN MEDICAL BIOGRAPHY

DR. I. FISCHER, of Vienna, is engaged in the preparation of supplementary volumes to the second edition of Hirsch's "Biographisches Lexikon der hervorragenden Aertze aller Zeiten und Völker" (Berlin and Wien, 1884–6), which is the only international dictionary of medical biography in existence. The supplement will contain biographies of recent and living physicians, and Dr. Fischer is particularly anxious to obtain American material, the conditions for inclusion being original laboratory and clinical work, important discoveries and inventions, publications, editorial work and such like. Any help which may be given him by the donation of "Who's Who," volumes of biographical sketches, clippings of important obituaries from medical periodicals, etc., will be much appreciated. Such material may be transmitted directly to Dr. Fischer himself (address: Biberstrasse 15, Vienna, I, Austria).

F. H. GARRISON

ARMY MEDICAL MUSEUM

SCIENTIFIC BOOKS

Outlines of Biochemistry (The Organic Chemistry and the Physicochemical Reactions of Biologically Important Compounds and Systems.) By ROSS AIKEN GORTNER. John Wiley and Sons, New York, 1929.

THE success of the application of physics and chemistry to biology depends upon two conditions: first, the ability of the biologist to master physics and chemistry and yet remain a biologist, and second, the willingness of the physicist and the chemist to cooperate sympathetically with the biologist. Professor Ross Aiken Gortner is an outstanding example of the fulfilment of the first condition. In reading his "Outlines of Biochemistry," it would be difficult to say whether Professor Gortner is biologist or chemist. He speaks to both in their own language, an attribute which few possess.

The second condition, that of the willingness of the physicist and the chemist to join hands with the biologist, is one which is differently viewed by people on both sides. There is the biologist who sees only futility in the attempt to solve vital problems in terms of physics and chemistry. Often have I received the injunction from biologists to remain a pure physiologist and not venture too far into the fields of physics and chemistry; and often have physicists and chemists said to me, "Good Lord, you talk of the structure of protoplasm, a *living* thing of tremendous complexity, and I do not yet know the structure of gelatin," or, "Why speak of the plasticity of protoplasm when we do not know the full meaning of this property as applied to paint and starch?" Fortunately, not all of us are of this mind. A delightful example of the opposite view-point came to my attention this past summer, and it came soon after I had heard the plaintive cry of a biologist who all his life has attempted to apply physical and chemical laws to biological processes, and now, with his work over, looks back on it as a failure. But not so Geheimrat Fritz Haber. We had just heard a lecture at the Kaiser Wilhelm Institute on sexuability in the lower organisms, and we waited, hoped, for some suggestion of the cause of the phenomenon, just one thought beyond the experiments, but none came. (I believe it was Professor Gortner himself who once said, "Science consists not only in the assembling of facts but in the marshaling and interpretation of these facts.") Fritz Haber then arose and told how he had long looked forward to the time when biologists would search for the cause of such characteristics of organisms as sex intergrades, in the specific nature of the proteins, the polarity of the proteins, of the respective individuals. Now, the task which Haber has given the biologist is a big one; how are we to isolate these proteins, and how then determine those specific characters which are responsible. But Haber's point of view is as far-sighted as it is courageous; he has a vision into the future, and it is such a vision, based on sound experimentation, which Professor Gortner gives us in his "Outlines of Biochemistry."

The book is of nearly eight hundred pages, well illustrated and excellently printed. There are thirty-five chapters separated into seven parts as follows: I. The Colloid State of Matter; II. Proteins; III. Carbohydrates and Allied Compounds; IV. The Tannins; V. Plant Pigments; VI. Fats, Lipides and Essential Oils; VII. The Biocatalysts.

Students often come to me and ask what book they should get in order to familiarize themselves with colloid chemistry, and until now I have had to tell them that there is no book which meets their specific requirements. Professor Gortner has supplied this need in Part I of his volume.

One of the valuable features of the book is brought out in the first part. Professor Gortner again and again calls attention to the many applications of a fact or an experiment in related fields; thus, in defining hysteresis he points out that although the word refers to a lag of some sort when used both in biochemistry and in engineering practice, yet the term is not the same in the two cases.

The last section of Chapter VI is on adsorption. This subject, which has played so important a part in Professor Gortner's own work, is treated fully and well. The theory of adsorption is first discussed, and then problems and applications given. There is included a definition of "negative" adsorption. Here is a term I have never liked. I react to it as I do to the popular conception of suction as a "negative" pressure, and to the definition of osmosis as "diffusion from a region of low concentration to one of high concentration." The difficulty in all these cases is, that while the thing we are thinking about is apparently negative, somewhere else in the system there is a positive force which is the cause of the supposed negative event; thus, in "negative" adsorption the solvent is positively adsorbed.

In the chapter on gels there is a useful discussion of imbibition and the rôle of water in the living organism—this might well have been made a chapter by itself. There is included an account of one of Professor Gortner's contributions to agriculture, on the nature of winter hardiness in wheat. In this connection the important fact is stressed that the biochemistry of both plant and animal cells has much in common, for the same factors which enable plant cells to live through the winter are likewise factors in the winter hardiness of insects. Work of this character, in what is usually referred to as "applied" botany, is an excellent example of the close interrelation of theoretical science and practical needs, and of the application of the one to the other. Indeed, Professor Gortner repeatedly shows, both in his work and in his book, how true is Pasteur's exclamation, *"Non, mille fois non, il n'existe pas une catégorie de sciences aux quelles on puisse donner le nom de sciences appliquées. Il y a la science et les applications de la science, liées entre elles comme le fruit et l'arbre, qui l'a porté."*

Part II, on proteins, takes the subject up systematically with interesting chapters on the structure of proteins, and the biological (immunological) reaction of proteins. The remark of Fritz Haber (quoted above) is substantiated in Professor Gortner's treatment of the proteins and in the introductory quotation from Emil Fischer: *"Da die Proteinstoffe bei allen chemischen Prozessen im lebenden Organismus auf die eine oder andere Weise beteiligt sind, so darf man von der Aufklärung ihrer Struktur und ihrer Metamorphosen die wichtigsten Aufschlüsse für die biologische Chemie erwarten."* Pauli has also laid emphasis on the proteins as the ultimate seat of vital phenomena in saying that "they alone display the specific properties of living matter."

In discussing certain phases of the controversy precipitated by Jacques Loeb, on the relative importance of the H ion, as compared with other ions, on adsorption, degree of peptization and like phenomena, Professor Gortner states that "we have here a lyotropic series . . . the degree of peptization can be due only to a specific influence of the anions, . . . proteins must be considered not alone as complex organic compounds but likewise as colloid micelles, subject to all the varied reactions of a lyophilic system." It is interesting to see the pendulum swing back again to Nägeli's micellae and Hofmeister's series.

The biologist will be particularly interested in the chapter on "The Biological Reactions of the Proteins" since this includes a consideration of phylogenetic relationships as determined by serological reactions.

Part III is on the carbohydrates. It includes sections on photosynthesis and fermentation. Here, as elsewhere, the book shows its special value to the general botanist and zoologist, and again in Part V on plant pigments where the relationship between blood pigments and chlorophyll and the chemistry of color inheritance are considered.

Five chapters on fats, lipides, oils, vitamins (prepared by L. S. Palmer) and enzymes complete the book proper. Eight pages of general reference and two indexes are appended.

In addition to its scientific value—and this can not be overestimated—there is a human, or philosophic side to Professor Gortner's book which is especially fine. In discussing histamine he says, "Toad skin, according to Pliny, was a medicine. Abel showed that it contained a powerful drug. This is an additional instance where one of the old folk remedies was found to be not so foolish as it appeared to be." In many similar remarks one realizes that the author is a man who, though taking his work seriously, still appreciates the uncertainty and the humor in science.

WILLIAM SEIFRIZ

UNIVERSITY OF PENNSYLVANIA

REPORTS

THE CANCER RESEARCH FUND OF THE UNIVERSITY OF PENNSYLVANIA

THE Cancer Research Fund of the graduate school of medicine of the University of Pennsylvania has received a gift of $210,000 from a philanthropist who does not desire to have his name revealed. It has been realized for some time that progress in cancer research work depends upon the association of the physician, the biologist and the chemist and upon the close cooperation of related clinics and laboratories. And now, as the result of the generous support which has just been given by a philanthropist from whom the Cancer Research Fund will receive $70,000 annually over a period of three years, the school has been placed in a position to carry on the cancer research work along these broad cooperative lines to an extent which heretofore was impossible.

One joint research project has been undertaken in association with the Bartol Research Foundation of the Franklin Institute, which is one of the great physical research institutes of the country, while research work has also been arranged for in association with the American Oncologic Hospital, a cancer hospital at Thirty-third Street and Powelton Avenue.

Plans are being developed for the equipment of a new clinic for modern diagnosis and treatment of tumors in the American Oncologic Hospital, and Dr. George M. Dorrance, professor of maxillo-facial surgery in the school of dentistry of the university, has been appointed chief of the clinic. Dr. Dorrance is assembling a group of specialists of the highest type to serve on the clinic staff, and the American Oncologic Hospital will be developed gradually into an anti-cancer center of the most complete character. Central laboratories of the Cancer Research Fund have been established at 133 S. Thirty-sixth Street, and here a complete tissue culture department is under the direction of Dr. Clarence E. McClung, professor of zoology at the University of Pennsylvania, and Professor David H. Tennent, of the department of zoology of Bryn Mawr College. Professor J. P. M. Volgelaar, of the University of Leyden, Holland, and Dr. Raymond C. Parker, the latter of whom recently was connected with the Kaiser Wilhelm Institute of Biology in Berlin, also have been added to the staff of the tissue culture department, and eight other research workers will be maintained in this department.

The central laboratories also have an experimental animal cancer department under the immediate direction of Dr. Shigemitsu Itami, who has had ten years' experience at the Crocker Cancer Institute of New York and four years with the British Empire Cancer Campaign in London, and who is assisted by a chemist and zoologist. Research work in radiation and other physical aspects of cancer is being carried on in the central laboratories in collaboration with the Bartol Institute, and for this purpose the Cancer Research Fund is maintaining two physicists, two chemists and a scientific secretary.

At the Philadelphia General Hospital the Cancer Research Fund has had for some time a research laboratory for the study of biochemistry of the blood before and after radiation of patients, and for the study of the hematology and immunology of cancer. This laboratory works in conjunction with the cancer clinic of the Philadelphia General Hospital, and has a staff of three chemists, one immunologist, one physician and one voluntary worker.

In addition to maintaining the laboratories mentioned, the Cancer Research Fund has made a number of grants for investigation to be carried on by research workers in collaboration with the work of the fund. These are as follows: A study of the metabolism of cells, by Professor W. D. Bancroft, of Cornell University; a study of the fixation of pathological material, by Dr. Henry J. Fry, of New York University; a study of the sensitization of cells to fluorescent substances and specific wave-lengths of X-rays, by Professor Eric Ponder, of New York University, and a study of the quantitative spectrographic estimation of minute quantities of substances in biological material, by Dr. Andrew Dingwall, of the department of chemistry, Columbia University.

In connection with the last-named study the fund has established a fellowship under the name of the Dr. J. Packard Laird Fellowship for Cancer Research; this fellowship is held at present by R. J. Crosen, of Columbia University. Another fellowship to be known as the Dr. John G. Clark Fellowship in Cancer Research also is being established.

The director of the cancer research is Dr. Ellice McDonald, assistant professor of gynecology in the graduate school of medicine of the university, and the Cancer Research Fund is controlled by an executive committee consisting of Dr. McDonald, Dr. George H. Meeker, dean of the graduate school of medicine, and Professor W. F. G. Swann, director of the Bartol Research Foundation and special lecturer on electrical engineering at the university.

In addition there is the following board of scientific directors of the research: Dr. McDonald, *chairman;* Dr. Meeker; Professor Swann; Dr. John A. Kolmer, professor of pathology and bacteriology in the graduate school of medicine; Dr. Eugene L. Opie, professor of pathology in the graduate school of medicine; Dr. Martin Kilpatrick, assistant professor of chemistry, University of Pennsylvania, and Dr. Clarence E. McClung, professor of zoology at the university. The board of scientific directors has recently established a publications committee with Dr. Opie as chairman.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A DIET FOR STOCK RATS

DURING the past seven years the stock rats of this laboratory have been reared on a diet which has given uniformly satisfactory results from the standpoint of growth and fertility and which has the further advantage of being obtainable ready-mixed at a very reasonable cost.

This ration was originally developed by Maynard, Norris and Krauss[1] as a feed for young calves. It was later tried out with rats with such good results that it was adopted as our stock diet. The formula[2] for this diet as now used is as follows:

300 lbs.	Linseed oil meal
200 "	Ground malted barley
440 "	Wheat red dog flour
300 "	Dried skim milk
300 lbs.	Oat flour
400 "	Yellow corn meal
20 "	Steam bone meal
20 "	Ground limestone
20 "	Salt

Originally the formula contained some soluble blood flour, a special product which later became difficult to obtain and which was therefore replaced by the dried skim milk. The diet is used as the sole ration, with the exception that cod-liver oil is fed twice a week, mixed in as 3 per cent. of the day's food. No green food of any kind is supplied.

The mean growth curves for our rat colony, plotted upon a semi-logarithmic scale, are shown in the chart. The animals providing the data for these curves were weaned at twenty-three days of age. The foundation rats for our colony were obtained from the stock of Osborne and Mendel. Since 1919 no animals from any outside source have been introduced.

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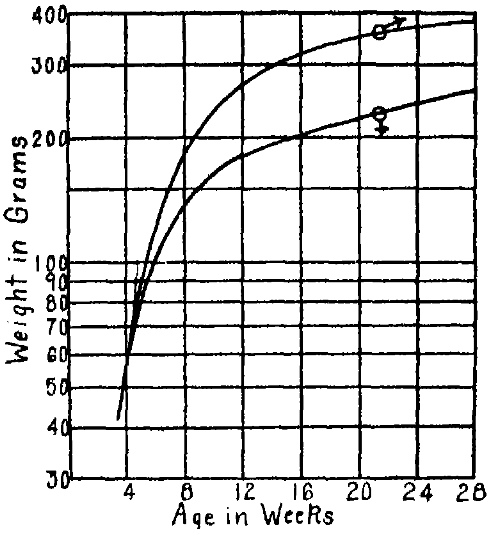
[1] Cornell Agr. Expt. Sta. Bull. 439, 1925.

[2] This formula is marketed as a ready-mixed feed under the name G. L. F. Calf Meal by the Cooperative G. L. F. Exchange, Buffalo, N. Y.



Growth curves of stock rats. Plotted on a semi-logarithmic scale diagram.

The efficiency of this diet for reproduction is indicated by the following data. In August, 1929, all the females of the stock colony which were over one hundred days of age and less than one year were mated. Of this group fifty-two were young females which had never before been mated and twenty-eight were mature animals which had produced one or more litters. A male was placed with each three females and left with them for a period of five days. All the males were young and untested as regards fertility. From these matings fifty-two of the females, 65 per cent., produced litters. In view of the fact that most of the animals used were young and untested and that the mating period was limited to five days, we feel that the above records indicate a high degree of fertility. The average number per litter from the above matings was 7.3. Each mother was given six young to rear with the exception of thirteen mothers which were given five only. Thus the fifty-two mothers were allowed a total of 299 young. Of this number over 90 per cent. were reared and successfully weaned at twenty-three days of age.

Recently this stock diet has been tried out with rats in three other laboratories and uniformly satisfactory results have been reported to us. During the past year we have used it as a stock diet for our mouse colony with excellent results. Since this ration is mixed in hundreds of tons for marketing as a calf meal, it is available at a price which is very much lower than the cost of the ingredients and labor involved in the preparation of stock diets in small quantities in experimental laboratories.

L. A. Maynard

Laboratory of Animal Nutrition,
Cornell University

AN IMPROVED CALOMEL ELECTRODE VESSEL

In much previous work in this laboratory the salt bridge connecting cell and electrode has been a cotton string wet with KCl solution of the same concentration as that used in the electrode. This string led into a beaker into which also dipped a calomel electrode tip of a conventional type. When six or more electrodes were used on a single cell, there was difficulty in getting the electrode tips with their attendant beakers close enough together. Even though the beakers stood on a paraffined bench, the slight contamination of the paraffin surface with moisture and spilt KCl gave cause to doubt the perfect insulation of the electrodes from the ground and from each other. An electrode vessel of the type shown in Fig. 1 was therefore used. The cup into which the string dips is blown onto the end of the electrode arm, which is long enough to permit placing the cups as close together as desired. The electrode arm enters the side of the cup, so that the entire surface of the electrode may be wiped with paraffin oil without oiling the solution in the cup. The arm is drawn to a capillary and extends to the bottom of the cup to prevent much mixing of the solution in the cup with that in the electrode. At the end of the day's work the cup is emptied with a pipette, more solution from the electrode vessel is flushed through and a rubber stopper is inserted to prevent evaporation of water and consequent creeping of KCl. The electrode vessel is held in a grounded metal clamp from which it is sufficiently insulated by the glass, oiled with paraffin. This electrode vessel has been found a great time-saver.

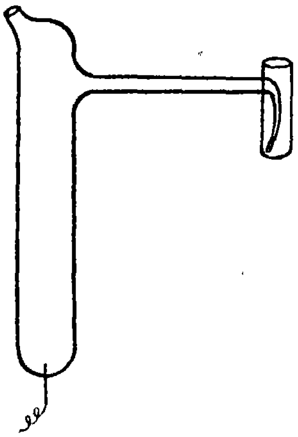


Fig. 1. Calomel electrode vessel with attached cup for string salt bridge.

Samuel E. Hill

The Rockefeller Institute
for Medical Research,
New York City

SPECIAL ARTICLES

OCEANOGRAPHIC INVESTIGATIONS IN THE INSHORE WATERS OF THE GULF OF MAINE

In the summer of 1929 a study of the biological, chemical and physical conditions of the inshore waters of the Gulf of Maine, in the vicinity of Mt. Desert Island, Maine, was undertaken by the Buffalo Museum of Science in cooperation with the Mt. Desert Island Biological Laboratory and Brown University.

The general plan of the work was divided and carried out by the various investigators as follows: Biological oceanology by Charles J. Fish; chemistry by Norris W. Rakestraw, and physical oceanography by H. R. Seiwell. Mrs. Charles J. Fish and Mrs. H. R. Seiwell assisted in the laboratory examinations of field data.

The field observations extended over the period from July 8 to August 21; investigations were made from Dyers Bay on the east (station 14) to Penobscot Bay on the west (station 18), and from the head of Frenchmans Bay on the north (station 2) to a point about fifteen miles south of its mouth (station 11).

The most intensive study was conducted at the eight stations established in Frenchmans Bay, four complete and two partial cruises being made in this region. Two sets of observations were made over the section extending from the head of the bay (station 2) to a point about fifteen miles south of the mouth (station 11). The small bays lying to the east were visited only once as also was Sommes Sound, and two sets of observations were taken each in Blue Hill and Penobscot Bay.

The arrangement of stations in the region was (Fig. 1): stations 1 to 8 were in Frenchmans Bay; stations 9 to 11 were to the south of Frenchmans Bay and were, together with stations 2, 7 and 8 of Frenchmans Bay, included in the north-south hydrographic section; stations 12 to 14 were in the smaller bays to the east of Frenchmans Bay, and stations 16 to 18 were in Sommes Sound, Blue Hill Bay and Penobscot Bay, respectively, to the west of Frenchmans Bay. In all a total of eighteen stations were worked at least once and usually twice or more, at which a total of 228 hydrographic observations were made. In addition ninety plankton collections were made from the surface and bottom water of the stations.

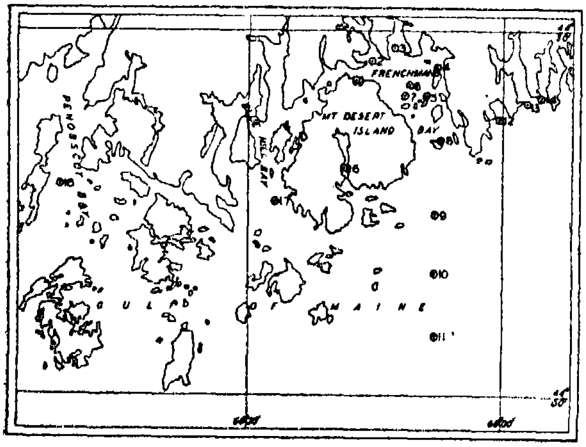


FIG. 1. Region of hydrographical investigations in the vicinity of Mt. Desert Island, Maine, July and August, 1929. Hydrographic stations marked thus—⊙

The hydrographic observations embodied the collection of temperature data and water samples for chemical analyses, from the surface, intermediate and the bottom depths. After a little experimentation it was found desirable to make all vertical hydrographical observations whenever possible at depths of 0, 5, 10, 25 meters and the bottom. All water samples were collected with Greene-Bigelow reversing water bottles to which were attached Negretti and Zambra deep-sea reversing thermometers. Six-millimeter wire was wound on a hand reel and passed over a Bergen Nautik meter wheel for measuring the depth of observation. All observations were conducted after the methods adopted by deep-sea oceanographers. Field headquarters were established during the summer at the Mt. Desert Biological Laboratory at Salisbury Cove, Mt. Desert, Maine. A small open boat, about eighteen feet in length, the property of the laboratory, was used for field operations.

The following is a very brief summary of the results of the physical observations made while the survey was in progress. The temperature is expressed in degrees centigrade and the salinity in grams of total salt per liter of sea water, represented by 0/00.

HYDROGRAPHICAL OBSERVATIONS IN FRENCHMANS BAY

Temperature.—Depth at stations, 12 to 86 meters. The average surface temperature ranged from 12.6° on July 8 to a maximum of 14.1° on July 31 and then to 12.0° on August 6; the average of all surface temperature observations was 12.8°. The maximum variation of surface temperature during the season was from 10.3° to 15.4° and the lowest temperature, 7.0°, was recorded at the bottom near the center of the bay. The water at the head was warmer than that at equal levels at the mouth of the bay. The average temperature of the whole bay from surface to bottom during the period of observation was 10.5°.

Salinity.—The average surface salinity increased from 31.73 0/00 on July 8 to 32.09 0/00 on July 31 and decreased to 32.04 0/00 on August 6; the average surface salinity of the whole bay was 31.91 0/00. The maximum variation of surface salinity during the season was from 31.51 0/00 to 32.25 0/00, and the highest salinity recorded, 32.45 0/00, was near the bottom at the mouth of the bay. The least saline water occurred at the head and the most saline at the mouth of the bay, but the variation at any one time was never of very great magnitude, the maximum recorded being 0.54 0/00. The average salinity from surface to bottom of the whole bay during the season was 32.04 0/00.

HYDROGRAPHICAL OBSERVATIONS AT STATIONS WEST OF FRENCHMANS BAY

Blue Hill Bay (station 17) depth 80 meters. Temperature ranged, July 26, from 14.06° surface to 10.06° bottom, and on August 20, 13.81° surface to 11.10° bottom. The temperature below twenty-five meters was one to two degrees higher than in Frenchmans Bay. Salinity ranged, July 26, 31.60 0/00 surface to 32.12 0/00 bottom, and on August 20, 31.83 0/00 surface to 32.34 0/00 bottom. The surface salinity was about 0.50 0/00 lower than in Frenchmans Bay.

Penobscot Bay (station 18) depth 58 meters. Temperature ranged, July 27, 14.98° surface to 8.70° bottom, and on August 21, 13.07° surface to 10.0° bottom. The temperature below twenty-five meters was a little higher than in Frenchmans Bay. Salinity ranged, July 27, 27.72 0/00 surface to 31.98 0/00 bottom, and on August 21, 30.30 0/00 surface to 32.09 0/00 bottom. The surface salinity was the lowest observed in the region investigated and was 2.00 0/00 to [illegible]/00 lower than in Frenchmans Bay.

Sommes Sound (station 16) depth 27 meters. Temperature ranged, July 26, 14.95° surface to 11.0° bottom, the temperature below five meters was a little higher than in Frenchmans Bay. Salinity ranged, 31.91 0/00 surface to 32.05 0/00 bottom, about the same as at the upper shallow end of Frenchmans Bay.

HYDROGRAPHICAL OBSERVATIONS AT STATIONS EAST OF FRENCHMANS BAY

Prospect Harbor (station 12) depth 16 meters. Temperature ranged, July 23, 12.59° surface to 9.11° bottom; salinity ranged 32.09 0/00 surface to 32.08 0/00 bottom. Both temperature and salinity were about the same as at the mouth of Frenchmans Bay.

Gouldsboro Bay (station 13) depth 18 meters. Temperature ranged, July 23, 12.86° surface to 10.40° bottom, the whole column of water was 0.3 to 1.3 degrees warmer than Prospect Harbor. Salinity ranged, 32.09 0/00 surface to 32.14 0/00 bottom, about the same as previous station.

Dyers Bay (station 14) depth 9 meters. Temperature ranged, July 23, 10.72° surface to 10.01° bottom; salinity 32.10 0/00 surface to 32.14 0/00 bottom. Temperature and salinity were about the same as at the mouth of Frenchmans Bay.

HYDROGRAPHICAL OBSERVATIONS AT STATIONS SOUTH OF FRENCHMANS BAY

On July 16 the surface temperature at station 10 was 10.42°, or about 1 degree lower than the temperature at the mouth of Frenchmans Bay lying ten miles to the north, while the temperature at 50 meters, 7.4°, was practically the same. On August 3, the surface temperature at station 11 was 10.0°, or 1.2 degrees lower than at the mouth of Frenchmans Bay lying fifteen miles to the north, while the temperature at 50 meters 8.1° was about 0.2° lower.

The surface salinity at station 10 on the former date was 32.10 0/00, or 0.06 0/00 lower, and the 50-meter salinity 32.52 0/00, or 0.18 0/00 higher than at the mouth of Frenchmans Bay. On the latter date the surface salinity at station 11 was 32.54 0/00, or 0.34 0/00 higher, and the 50-meter salinity 32.70 0/00, or 0.35 0/00 higher than at the mouth of the bay.

H. R. SEIWELL,
Curator, Invertebrates and Oceanography
BUFFALO MUSEUM OF SCIENCE

THE RELATION OF THE OXYGEN TENSION IN THE EXTERNAL RESPIRATORY MEDIUM TO THE OXYGEN CONSUMPTION OF FISHES

RECENTLY two American articles by Powers and Shipe[1] and F. G. Hall[2] have had the above relation as their subject, and in both cases the conclusion was drawn that the fish's oxygen consumption is proportional to the oxygen tension of the environment, even when a restricted range of the latter within the normal concentration of natural waters is considered. It is perhaps unnecessary to emphasize the theoretical and methodological importance of such a conclusion. Unfortunately it appears for a number of reasons quite certain that this conclusion can not be accepted without qualification.

Before demonstrating that this conclusion is unwarranted at the present time, let me hasten to say that, as would be expected, the respiration of fishes is undoubtedly depressed at low levels of oxygen tension of the environmental water. Such a depression of respiration as the oxygen tension approaches the asphyxial threshold by no means implies a depression of oxygen consumption brought about by deviations within the normal range of oxygen concentration in the environment. For sea water we may consider this normal range to be from 4.5 to 6.5 cc per liter at temperatures of 15° to 20° C.

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[1] E. B. Powers and L. M. Shipe, *Publ. Puget Sound Biol. Sta.*, 5: 365–372, 1928.

[2] F. G. Hall, *Am. J. Physiol.*, 88(2): 212–218, 1929.

A careful consideration of the data presented by Powers and Shipe in support of their contention fails to reveal any adequate indication of a direct relationship between O_2 tension and O_2 consumption in the restricted range we are considering. The fact that their experimental conditions were not standard may account for the fact that a number of their recorded values for oxygen consumption (cc per kilo per hour) are several times those previously reported for fishes. As for Hall's evidence, it is to be regretted that it is inadmissible on the grounds of faulty technique. Hall used a modified Ege and Krogh[3] apparatus in which the oxygen tension of the water was controlled by varying the rate of flow; in other words, the concentration of oxygen was diminished by the respiration of the fish and was then rebreathed in the large respiratory chamber used. It is obvious that the fish is excreting carbon dioxide at approximately the same rate that it is using oxygen and, even in a buffered system such as sea water, this will displace the hydrogen-hydroxyl-ion equilibrium and lower the pH. The marked effect of carbon dioxide on respiration is too well known to require comment. In addition, the accumulation of nitrogenous excretions in the water may possibly exert some effect.[4]

Hall mentions the work of Winterstein[5] in which it was concluded that the oxygen consumption of the fish (*Leuciscus*) is independent of the oxygen tension over a wide range. The important papers of Henze,[6] Gaarder[7] and Toryu[8] are apparently unknown to Hall and to Powers and Shipe. Henze concluded that the oxygen consumption of fishes is entirely independent of the oxygen of the water down to the threshold of asphyxia. Toryu drew similar conclusions from his experiments on the goldfish. Gaarder, using precise methods, found some indication of a direct relation between the oxygen tension in the water and the oxygen used by the fish, but concluded that, within a limited range, the oxygen consumption may be considered to be practically constant.

In my own experiments, water of really low oxygen tension was not used; the minimum concentration was 4.56 cc per liter. My methods were similar to those of Gaarder, but I did not narcotize the fishes as he did. Experiments on the same individual fishes (*Fundulus parvipinnis*), under identical conditions except for the oxygen tension of the water, did not give the slightest indication that the oxygen content of the water has any effect upon the respiration, but on the contrary the oxygen consumption was practically constant for any given fish. Experiments in which both the rate of flow and the oxygen concentration of the water were varied were likewise entirely negative, the respiration of the fish, based on the averages of a number of determinations, remaining remarkably constant, such deviations as were found having no relation to the available oxygen.

After considering all the available evidence it seems clear that the time has not yet come when we can make any very broad generalizations as to the relation of the oxygen tension of the environment to the oxygen consumed by the fish, but certain features are salient: (1) the respiration of fishes is very decidedly decreased at or near the asphyxial level of oxygen tension, and (2) in the respiration of the fishes so far investigated there seems to be practically a complete independence of deviations in the oxygen content of the water within a restricted range.

The practical importance of establishing this last point will be seen when it is pointed out that the methods which have previously been used for the estimation of the standard metabolism of fishes depend upon such an independence of the fish's respiration for their validity.

A more detailed discussion and presentation of evidence will shortly appear in the technical series of t[illegible] of the Scripps Institution of Oceanogra[illegible] Th[illegible]versity of California Press.

Ancel B. Keys

Scripps Institution of Oceanography

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[3] R. Ege and A. Krogh, *Internat. Rev. ges. Hydrobiol. Hydrog.*, 7(1): 48–55, 1914.

[4] H. W. Smith, *J. Biol. Chem.*, 81(3): 727–742, 1929.

[5] H. Winterstein, *Pflüger's Arch. ges. Physiol.*, 125: 73–98, 1908.

[6] M. Henze, *Biochem. Zeitsch.*, 25: 255–278, 1910.

[7] T. Gaarder, *Biochem. Zeitschr.*, 89: 94–125, 1918.

[8] Y. Toryu, *Sci. Rept. Tohoku Imp. Univ.*, 4 ser. 3 (1): 87–96, 1927.

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INHERITANCE IN A HEPATIC[1]

By Professor CHARLES E. ALLEN

UNIVERSITY OF WISCONSIN

I

THE studies here outlined were suggested by the presence in Sphaerocarpos of these advantageous conditions: (1) The presumable relative simplicity of inheritance in a haploid generation, yielding hybrid ratios that may be tested in comparatively small families, free from complications of dominance and recessiveness. (2) The opportunity for an exhaustive study of a given genotype, expressed through a clone ordinarily requiring little space but potentially unlimited in extent and duration. (3) The permanent adherence, in most species and races, of the four spores derived from each mother cell, making possible a virtually immediate determination of the genetic effects of meiosis.

While the predominant generation of Sphaerocarpos is simpler, because haploid, than the diploid organisms chiefly studied by geneticists, the phenomena of inheritance in this genus need not be expected, and do not appear, to be simpler in any other sense. The genus is probably the present climax of as long an evolutionary development as is the pea or the banana-fly. Sexual differentiation, so far as concerns gametes and the organs in which they are borne, is at approximately the highest point reached by any plant. Dioecism and sexual dimorphism are fixed and constant. The chromosome complex is comparable with that of any "higher" organism. Allosomes, in differentiation and in the correlation between their distribution and the appearance of sexual characters, resemble those of many Metazoa. The frequency of mutation is comparable with that elsewhere observed. In the longest series of experiments yet summarized,

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[1] Address of the retiring vice-president of Section G—Botany, American Association for the Advancement of Science, Des Moines, Iowa, December 31, 1929.

1,273 gametophytes of known ancestry were determined as to sex and vegetative character. Of these, five—about 0.4 per cent.—were apparent mutants. Two were marked variants never before seen.

II

It is possible in plants of various orders to study the characters of gametophytes developed from spores recognizably derived from the same mother cell. Long ago Strasburger pointed out the possibilities offered by Elodea, whose pollen grains remain adherent in tetrads. An analysis of this nature has been made by Wettstein of the distribution of certain characters in moss hybrids, and a considerable number of studies of Basidiomycetes have dealt with what is in effect the intra-tetrad distribution of factors affecting syngamy.

In the course of the work with *Sphaerocarpos Donnellii* Aust., extensive attempts have been made to apply this method of intra-tetrad analysis. The far-from-simple behavior of certain characters later mentioned has interfered with the success of many of these attempts. Rather satisfactory results have accrued, however, with respect to the distribution of sexual, and of at least one pair of what may be called vegetative, characters.

Thus far each clone, however long under cultivation or to whatever conditions subjected, has remained strictly male or strictly female. My observations, and those reported by others, have disclosed no change in sexual expression, no suggestion of hermaphroditism or of intersexuality. The female gametophyte is now well known to possess a large X-chromosome; the male has a very small Y-chromosome; the other seven chromosomes apparently correspond in size in the two sexes. The X- and Y-chromosomes are separated in meiosis; two spores of a tetrad receive each an X-chromosome and develop, if they germinate, into female gametophytes; two receive each a Y-chromosome and develop, if they germinate, into male gametophytes. To this rule my experiments have afforded no exception.

Polyclady, fully described elsewhere, affects the structure of practically all gametophytic organs, conspicuously of the antheridial and archegonial involucres. Female polycladous plants are completely sterile. Polycladous males are fertile with nonpolycladous females. From every such mating that yielded more than two f_1 offspring, the progeny of each sex included polycladous and nonpolycladous clones. No exception, save one mutant, has been observed to the rule that, of the spores of any tetrad resulting from a mating of a nonpolycladous female and a polycladous male, two are genetically polycladous and two nonpolycladous. Thus, a character-complex affecting the whole plant, far transcending generic lines as these are understood among bryophytes, behaves in a strictly unitary fashion.

If the two character-pairs concerned in such a mating—namely, maleness-femaleness and polyclady-nonpolyclady—were inherited independently, the f_1 generation would consist of equal numbers of clones of four types: female nonpolycladous, female polycladous, male nonpolycladous and male polycladous. That these types do not appear in approximately equal numbers was early apparent. It is now possible at least partially to explain these deviations from a simple expectation.

The genetic constitution of all the spores of a tetrad is established if all, by germination, give rise to clones that live long enough for their characters to be determined. If three spores thus produce clones, then, on the assumption justified by experience that two are genetically female and two male, two nonpolycladous and two polycladous, the genotype of the ungerminated spores is established. If two spores germinate, and the resultant clones are alike either in sex or in vegetative character, on the same assumption the genotypes of the two ungerminated spores are known. Of thirteen f_1 families whose fathers were polycladous, seven, as shown in Table I, have yielded material for an analysis in terms of tetrads. In the table only those tetrads are included which, as just indicated, were decisive.

TABLE I

GENETIC TYPES OF SPORE TETRADS (DECISIVE CASES ONLY) AMONG OFFSPRING OF NONPOLYCLADOUS × POLYCLADOUS

(p. = polycladous; np. = nonpolycladous)

Mating	I	II	III	Totals
	♀ 2np., ♂ 2p.	♀ 2p., ♂ 2np.	♀ 1np., 1p. ♂ 1np., 1p.	
14	—	1	—	1
28	2	1	—	3
29	5	2	1	8
31	12	7	3	22
32	13	6	5	24
33	7	1	2	10
40	—	1	1	2
Totals	**39**	**19**	**12**	**70**

Three classes of tetrads appear. Classes I and II are "two-type" tetrads; that is, both spores transmitting the same sexual tendency carry also the basis of the same vegetative character. Class III is composed of "four-type" tetrads, the spores of each representing the four possible combinations of sexual and vegetative characters.

The two classes of two-type tetrads differ in frequency of occurrence. Those of class I are about twice as numerous as those of class II, and a like difference holds for each family of any considerable size. The more numerous class is that whose spores represent the character-combinations of the respective parents; the smaller class, that whose spores represent new combinations of characters. A linkage between sex and polyclady is clearly indicated.

The familiar conception of sex-linkage is that of a character whose differential factor is borne on a sex chromosome. To apply that conception here, it would be necessary to assume a factor-pair borne on the X- and Y-chromosomes, and a crossing over during meiosis in about one third of the spore mother cells between each of the factors in question and some sex-determining factor. Apart from the questionable legitimacy of postulating a single pair of effective sex-determining factors (or even of factor-complexes behaving as units), the great difference in size between the X- and the Y-chromosome makes it extremely difficult to imagine a conventional crossing over between them.

A more probable explanation of the present facts seems to be that two chromosome pairs are concerned; one the X-Y pair affecting sex, the other a pair carrying the genetic bases for polyclady and its absence. The two chromosomes, one of either pair, derived from each parent must then tend to remain together and to pass to the same pole in each reduction division; and this tendency must be so strong that the chromosomes from the same parent do thus remain together twice as often as they are separated. Evidence is available in several angiosperms of an end-to-end attachment of chromosomes during meiosis which may lead to exactly such a behavior of chromosomes from the same parent as is here postulated. Such attachments are best known in Oenothera, but are not peculiar to that genus.

The occurrence of a minority of four-type tetrads bears directly upon the nature of meiosis. Cytological studies indicate that, in general, it is in the first reduction (heterotypic) division that the chromosomes of each pair are separated—one of the pair being in origin maternal, the other paternal. Evidence from plants is virtually unanimous on this point. In some insects, however, certain chromosome pairs, the sex chromosomes or others, are or may be separated in the second (homoeotypic) division. Now, if segregation occurs exclusively in the first division, the four nuclei ultimately formed (spore nuclei in the present case) must be, genetically, of but two sorts. That four-type tetrads occur implies that some segregation, of whole chromosomes or of chromosome parts, takes place in the second division.

Is it possible that in Sphaerocarpos *all* segregation occurs in the second division? A scheme for such segregation can be devised that will account for the production of two-type and four-type tetrads in the proportions here observed. But such a scheme involves rather far-fetched assumptions. On the simplest postulate of chance segregation in the second division only, equal numbers of two-type and of four-type tetrads should appear. *A priori* considerations then make segregation exclusively in the second division improbable. The argument is supported by the cytological evidence that segregation *appears* in virtually all plants studied to occur in the first division, and is made conclusive by the fact that in Sphaerocarpos the X-Y pair has been shown to separate in the first division—although the limited observations do not exclude the possibility of an occasional postponement of this separation to the second division.

It follows that some segregation is possible in the course of *both* divisions. Interestingly, a similar conclusion is reached by Dodge in his study of inheritance through ascospores in *Neurospora sitophila*. In that, as in the present case, two possibilities suggest themselves: either that some or most of the chromosome pairs are separated in the first division, at least one pair, however, separating regularly or occasionally in the second; or that all pairs separate in the first division, their separation being preceded by a crossing over in at least one pair of autosomes in the "four-strand" stage.

From the proportions shown by Table I for the respective classes of tetrads, it is easy to calculate the proportion in which clones of the four possible types would be expected to appear in the f_1 generation. The calculation gives: 9 ♀ nonpolycladous: 5 ♀ polycladous: 5 ♂ nonpolycladous: 9 ♂ polycladous. With this ratio may be compared the total numbers of clones of the various types obtained in f_1 progenies, as shown in Table II. Since knowledge of tetrad relationships is not essential here, this table includes much more material than did Table I.

The numbers of female types shown in Table II agree closely with the calculated proportions (266:148). The numbers for males depart rather widely from calculation, which, based upon numbers of males only, would give 118:213. As to this discrepancy, it is to be said that, since males succumb to unfavorable conditions more quickly than females, the major portion of the clones that died before their character could be satisfactorily determined were doubtless male. The females therefore present a more accurate picture of the genetic make-up of the population. Apparently it is necessary to assume in addition some difference in viability between the two types of genetically male spores.

TABLE II

RESULTS OF MATINGS OF NONPOLYCLADOUS × POLYCLADOUS; TOTAL OFFSPRING

p. = polycladous; np. = nonpolycladous)

Mating	♀ np.	♀ p.	♂ np.	♂ p.	p. (sex?)	Undet.
12	—	—	1	—	—	—
13	46	28	28	21	3	11
14	17	9	9	7	—	11
15	34	30	29	13	3	28
27	19	14	14	12	—	4
28	6	6	6	4	—	—
29	5	5	9	8	—	2
30	—	—	—	2	—	—
31	31	11	22	20	—	3
32	39	24	23	25	—	12
33	22	2	8	12	5	9
34	34	20	23	33	—	3
40	6	6	1	1	—	1
Totals	259	155	173	158	11	84

If another character-pair were concerned, ratios would evidently become more complex. Some matings have involved "tuftedness" in addition to sex and polyclady. The tufted character, as will appear, is variable, and results obtained with it must be stated cautiously. An additional difficulty is introduced by the fact that polyclady masks tuftedness, so that a polycladous tufted clone can not be distinguished by its appearance from a polycladous nontufted clone of the same sex. However, a few reasonably definite results may be cited. If a mating is made in which the father is polycladous and either father or mother is genetically tufted, then, apart from certain apparently possible but rare distributions of the tufted character, four classes of two-type tetrads and eight classes of four-type tetrads may be expected. A limited number of such matings have apparently yielded all the expected two-type classes and at least four of the eight expected four-type classes. Since the numbers of classifiable tetrads are yet low, and since the four-type classes must appear in but small proportions, it is probable that a mating of the sort in question would, in a numerous progeny, yield all the expected tetrad classes. Of those classes that have appeared, the small numbers do not justify a conclusion as to proportions, save that, as before, the two-type classes whose spores carry the parental combinations of genetic bases for polyclady or its reverse and sex are larger than those whose spores carry new combinations of these bases.

The results here given suffice to indicate that the intra-tetrad analysis of characters furnishes a direct method of attack upon the phenomena of Mendelian segregation, making possible, for example, a more accurate explanation than otherwise of crossing-over ratios; and also that it throws some light upon details of chromosome behavior that still elude cytological observation.

III

In consequence of the great difference in size between X- and Y-chromosomes, the female gametophyte of Sphaerocarpos possesses, cell for cell, a greater volume of chromosome substance than does the male. The advantage of the female in this respect is conservatively estimated at 50 per cent. Since the mother contributes a so much greater bulk of hereditary substance to the sporophytic progeny, it might be expected *a priori* that the constitution of a sporophyte would betray more evidence of maternal than of paternal influence.

An instance of preponderant maternal influence in the sporophyte appears in the inheritance of the tendency for spores to adhere, or not to adhere, as the case may be, permanently in tetrads. All the spores produced by any sporophyte are adherent or separate according as the mother of that sporophyte carried the one tendency or the other, and quite independently of the genetic constitution of the father. The tendency in question is sex-linked in transmission, although it appears in an asexual generation. Its inheritance has been tentatively explained by a factor carried on the X-chromosome and hence transmitted only through females.

A behavior perhaps closely comparable is observed in certain interspecific hybrids. Most attempts at crossing *S. Donnellii* and *S. texanus* Aust. have failed. But numerous hybrid sporophytes have been obtained from female plants of a strain of *S. texanus* from Arkansas mated with male plants of *S. Donnellii*, and a very few from a similar cross involving plants of *S. texanus* from Mississippi. The reciprocal cross has not yet succeeded. The most readily recognized distinctions between the two species are in the form and sculpturing of the spore and tetrad walls. In these respects all the spores and tetrads produced by the hybrid sporophytes resemble those of the maternal species. Such spores have thus far refused to germinate; but so far as the results go, the inheritance of spore-form and -structure follows the same rule as does that of spore-adherence or -separation. It may or may not be of wider significance that the only sporophytic characters whose inheritance it has yet been possible to study are determined by the genetic constitution of the mother.

The possible transmission of a preponderant maternal influence through the sporophyte to f_1 gametophytes is a less simple matter. The X-chromosome passes, apparently intact, to the female gametophytes; the Y-chromosome to the male gametophytes. With respect to the autosomes, the female and male gametophytes are apparently alike; apart, therefore, from differences between the sexes correlated with the presence of an X- or a Y-chromosome, no preponderant influence, either maternal or paternal, would be looked for in the f_1 gametophytes. Nevertheless, with respect to two characters something like a predominant maternal influence seems to be demonstrated in this generation.

One character is that designated "semisterile." Several semisterile male clones originated in plants of a single group, probably of common origin. They produce few antheridia. The semisterile character has remained constant through vegetative multiplication for more than eight years. A semisterile male mated with a tufted female produces typical and tufted offspring of both sexes, the typical (nontufted) tendency in this case being apparently inherited from the semisterile male ancestor. But no semisterile male, mated with a typical, tufted or appendiculate female, has ever produced semisterile offspring. The obvious explanation, that spores are formed carrying the semisterile tendency but unable to germinate, seems to be negatived by the fact that in numerous cases three, and in fewer instances all four, spores of a tetrad have germinated. It appears thus far, then, that the semisterile tendency, though constant so far as vegetative multiplication is concerned, can not be transmitted by a male parent through gametes and spores.

The second character, "cupulate," appeared in a male mutant. A cupulate male bears small crowded antheridia subtended by involucres which are predominantly saucer- or cup-shaped. This character has remained constant for five years through vegetative multiplication. The clone has proved fertile in two matings. In the one f_1 family obtained, no cupulate offspring appeared. So far as present results show, the cupulate tendency also is not inherited from the male parent through gametes and spores.

Thus phenomena suggesting the exercise of a predominant effect by maternal substances are found in both sporophyte and gametophyte. Those observed in the sporophyte may be explained by influences emanating from the X-chromosome; those noted in the gametophyte are not thus readily explainable, unless it can be imagined that factors borne on the X-chromosome may, by crossing over or by other means, be transferred to male progeny.

However, such a failure of paternal characters to reappear in f_1 gametophytes has much in common with certain instances of matrocliny in angiosperms which now tend to be explained in terms of cytoplasmic inheritance. A similar conception is nowhere more applicable than in a bryophyte, the cytoplasm of whose zygote is almost exclusively maternal.

IV

A somewhat similar failure of paternal tendencies to manifest themselves in the offspring may assist in explaining the puzzling nature of the inheritance of "tuftedness." This character distinguishes certain clones of *S. Donnellii,* the frequency of whose appearance in my original cultures suggests that tufted races are not uncommon in nature.

Tufted clones of either sex are marked by peculiarities in manner of growth and to some extent in vegetative structure, but most conspicuously by aberrancies in the forms of archegonial and antheridial involucres. A tufted clone produces tufted, typical and transitional branches, each of which may become an independent plant. The appearance of such a variety of branches is comparable with the variation that occurs among the branches of a variegated clone of Coleus, or with the less frequent appearance of bud sports in Citrus. In Sphaerocarpos the sporting process is reversible; a clone originating in a tufted branch gives rise sooner or later to typical branches, and a strictly typical branch from a tufted clone produces a clone that in time includes tufted branches. On the other hand, strictly typical *clones* exist which never produce tufted branches. Tufted clones and typical clones, then, differ genetically.

Their genetic difference is shown in another way. The f_1 progeny of a mating between a typical and a tufted clone includes both typical and tufted gametophytes of each sex. A mating between two typical clones gives rise to a gametophytic progeny exclusively typical—rare mutants being left out of consideration in each instance.

As between clones, differences in degree of expression of the tufted character are often conspicuous. While any clone varies from time to time in its degree of tuftedness, nevertheless, some clones have always during a term of years displayed a very large proportion of tufted branches—running, say, from two thirds to nine tenths or more. Others, growing during the same period in similar soil, in the same Wardian case, and subject, so far as possible, to precisely similar conditions, have shown only once or twice in a long life a few, possibly only one or two, distinctly tufted branches. Facts like these indicate that fixed hereditary differences, expressing themselves in differences in degree of tuftedness, exist between tufted clones.

The character of a clone may be indicated by the percentage which the total number of observed tufted branches bears to the total number of branches constituting the clone at the times at which a series of observations were made. Since this figure is based upon estimates and since the character of a clone varies, presumably in response to environmental changes, the absolute percentages calculated are not to be taken too seriously. They do, however, give a rough measure of inherent differences. Percentages so obtained range from a small fraction of one per cent. to as high as 98 per cent. One hundred per cent. tuftedness is never found; no tufted clone, living for a considerable period, has failed to produce at least an occasional typical branch. Tufted clones, then, constitute a series of an indefinite number of terms, ranging from almost complete tuftedness down to transitional types in which the distinction between tuftedness and nontuftedness is necessarily subject to error.

For some years experiments have been under way to test the effect of selection within tufted clones. In one series, a highly aberrant branch of each tufted clone was selected. This branch, isolated, served as the starting-point of a new clone. After the new clone had grown for some months, one of its most markedly tufted branches was similarly isolated, and the process has been repeated in various lines from eight to twelve times. In a parallel series, beginning with the same parental clones, a selection was similarly made in each instance of a strictly typical branch.

The result of these experiments was the production of clones which, growing for say six months, produced in the one series an increased proportion of tufted branches, and in the other series, an increased proportion of typical branches. Vegetative selection within a clone was to this extent effective. But when selection was suspended for from fourteen to seventeen months, the clones, representing the seventh or eighth selection in each line, growing and being transplanted from time to time, both those of high and those of low tuftedness reverted toward the average condition of the original parental clone. Intraclonal selection had not resulted in a lasting genetic change.

The question, however, arises how the apparent *temporary* change in character could be effected by selection. With this temporary effect of selection may be correlated the observation that a large tufted clone commonly includes patches, some of distinctly tufted, others of strictly typical, branches. Doubtless the expression of the tufted character is conditioned or affected by the environment. But in a three-inch pot of well-mixed soil, in all parts equally illuminated and equally moistened, it is difficult to explain the patchwork condition just described by localized differences in environment alone. Both the tendency to a patchwork arrangement and the temporary effects of selection indicate that a tufted branch tends more strongly to produce new tufted than new typical branches, and that a typical branch within the same clone similarly tends more strongly to produce new typical branches. To this behavior, also, analogies are to be found among angiosperms; see, for example, Darwin's classical discussion of bud variations, and Stout's study of variegated clones of Coleus.

It would be rash at present to attempt to formulate the difference in cellular constitution which, existing between a tufted and a typical branch, must supply the basis for a temporary difference in their (vegetative) reproductive behavior. Whatever the difference, it is superposed upon a fundamental and persistent genetic identity. The temporary difference may *possibly* be referable to some feature of cytoplasmic structure, which ultimately yields to the regulative action of the chromosomes.

It has been noted that genetic differences of a permanent nature seem to exist among tufted clones. To test the reality of such differences, matings have been made involving nontufted, little-tufted (1 to 12 per cent.) and much-tufted (55 to 93 per cent.) clones. The results of these matings, as determined by the characters of the f_1 gametophytes, are here presented in much-abridged form. Fuller details are embodied in a report now in press.

The possibility of error in the determination of genetically slightly tufted clones has already been alluded to. The danger of such error is greater in the classification of male than of female clones, because a larger proportion of males succumb comparatively early. With the qualification, therefore, that some errors of this type have undoubtedly occurred, the following results are presented.

Generally speaking, the more highly tufted parents produce on the average the more highly tufted offspring, less tufted parents less tufted offspring. While this is true in terms of averages, the individual clones of any family show a wide range in their proportion of tuftedness. One family (24) may be selected as illustrative. The average tuftedness of the mother was 6 per cent.; of the father, 12 per cent. The f_1 clones whose character was determined with some confidence included 37 nontufted and 38 tufted females, 14 nontufted and 12 tufted males. The degree of tuftedness among f_1 females ranged from less than one to 39 per cent.; among f_1 males, from 15 to 90 per cent. The average tuftedness of all tufted females was 11 per cent.—about twice that of the mother and approximately equaling that of the father. The average tuftedness of all tufted males was 44 per cent.—seven times that of the mother and nearly four times that of the father. The average tuftedness of all females, *including nontufted*, was 6 per cent.; that of all males, 20 per cent. The occurrence and distribution of so varied conditions within a single family fit the conception previously formulated of the existence of genetic differences between different tufted clones, leading to complexity in the method of inheritance of tuftedness.

The apparent intra-tetrad distribution of characters among the offspring of three types of matings involving tuftedness is shown in Table III. In this table was included every tetrad of which even a single spore gave rise to a clone whose character was determined. Thus, in the first column of the table tetrads are included which gave rise to but one or two nontufted females or to one or two tufted males.

TABLE III

APPARENT INTRA-TETRAD DISTRIBUTION OF OFFSPRING OF MATINGS INVOLVING TUFTEDNESS

(t. = tufted; nt. = nontufted)

Parents	2 ♀ nt., 2 ♂ t.	2 ♀ t., 2 ♂ nt.	Other tetrad groupings
Nont. × Much-t. (4 matings)	30	32	28
Little-t. × Little-t. (2 matings)	36	35	
Little-t. × Much-t. (1 mating)	6	8	1

Most of those tetrads produced by matings of nontufted × much-tufted that are classed under "other tetrad groupings" would fall into either the first or the second class in Table III if certain clones determined as nontufted really were genetically tufted. It is probable that in some proportion of these tetrads such a correction should be made. The class of "other tetrad groupings" includes, however, some tetrads three or all of whose spores bore the tufted tendency; possibly some tetrads three or all of whose spores were genetically nontufted, and apparently a few four-type tetrads.

The one instance among "other tetrad groupings" derived from a mating of little-tufted × much-tufted was apparently a four-type tetrad.

If tuftedness were inherited as though determined by a single factor, a mating of nontufted × tufted would be expected to yield tetrads of the two classes shown to be present in largest numbers, plus possibly some four-type tetrads. On the same basis, a mating of tufted × tufted would be expected to yield only tufted offspring. The odd fact indicated by Table III is that the matings therein included of tufted × tufted gave results agreeing more closely with the expectation, on a simple genetic basis, from matings of nontufted × tufted than did the results of the latter matings themselves.

In contrast, families derived from two much-tufted parents agreed closely with expectation. The offspring of five matings of this type were all, or almost all, tufted. Apparent exceptions were one female, a polycladous mutant in which tuftedness may have been masked by polyclady; and three apparently nontufted males, any or all of which, for reasons already given, may have been genetically tufted. The remaining 84 females and 42 males were unquestionably tufted.

These results, taken together, confirm the conclusion derived from other evidence that tufted clones may differ genetically. Stated in factorial terms, this implies that tuftedness is or may be due to several distinct factors, some or all of which are cumulative in their effects. But such multiple factors alone will not account for the intra-tetrad distribution of characters in the various types of matings described. An explanation offered in another place, postulating in addition complementary factors and certain linkage relations, fits fairly well the facts now available. This hypothesis need not be detailed here. It involves several assumptions, unfounded save as they were made to fit a complicated state of facts. The hypothesis may be somewhat simplified if it can be supposed that, as in the case of the semisterile and cupulate characters already discussed, certain factors contributed by a male parent may disappear or be inactivated in the offspring. It is true that not all paternal factors basic to tuftedness can be assumed always to be inactivated, for tuftedness has appeared among the progeny of nontufted mothers and tufted fathers. The suggestion of a maternal influence upon the expression of this character thus remains a mere suggestion, justified, however, by the observed fact that among the relatively few characters, sporophytic and gametophytic, yet experimented with, a surprising proportion, as pointed out earlier, evidence some preponderant influence on the part of the mother.

Possibly it may be permissible here to note that the behavior in inheritance of tuftedness does not, in itself, suggest the dependence of that character upon any number of specific, separable factors. The picture presented by the facts now known is that of a continuous series of genetic states ranging from the complete absence of tuftedness to its almost, but never quite, universal distribution over a clone of indefinite extent. The question might be posed whether, in dealing with a character of this nature, a factorial hypothesis can ever offer more than a purely formal explanation.

V

The results here presented, though incomplete, serve to indicate that the genetic behavior of different organisms may in important respects be very diverse, even though in other respects far-reaching similarities appear between forms so far apart phylogenetically as bryophytes, flies, angiosperms and mammals. It follows that a comprehension of the facts of inheritance and variation, and a recognition of the fundamental features of their mechanism, require the assemblage of information from all available sources, including adequately representative members of all plant and animal phyla.

THE ORGANIC WORLD AND THE CAUSAL PRINCIPLE[1]

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Some thirty centuries ago a Hebrew sage summed up the outcome of his observations by declaring that "there is no new thing under the sun." In those days man's knowledge of nature was absurdly limited. A contemporary critic might perhaps have challenged the dictum, but a final decision could not then be reached. As a matter of fact, Solomon, in those words, set forth a problem which has haunted the thinking man even to this very day. We are still asking the question: Does anything really new ever appear in the universe?

Taken superficially the statement is manifestly untrue. New aggregations of atoms are constantly taking place. Every fresh geological stratum, every individual organism, whether plant or animal, every chemical compound, is a new construction. But on the other hand, science is constantly demonstrating that these apparent novelties result, one and all, from the operation of certain general principles which hold throughout the entire known universe and which seem to have held throughout all time. The problem, as I see it, is really this: Granted that the material world is constantly changing, granted that all changes proceed according to certain rigid causal principles which we call the laws of nature and that these principles hold throughout the physical universe, we must ask: Has there appeared in the course of history any *new* principle—any mode of activity which is more than a direct corollary from these universal and eternal principles of cause and effect?

The answer is still very much in doubt. Those who incline to a mechanistic view of nature generally accept Solomon's conclusion. Vitalists and teleologists take the opposite position. They assume that new forces have somehow been brought into existence with the advent of organisms and conscious beings into the world. And there has recently come into prominence another conception of things, the theory of emergent evolution, which may take either a vitalistic or a mechanistic form, but which distinctly challenges the ancient aphorism. This theory also declares emphatically that new and unpredictable properties come into being from time to time as new systems of material units are generated.

With the vitalistic conception I have never had much sympathy. It may reasonably be assumed that most of the novelties which seem to emerge in the course of evolution are not strictly novelties at all—that the laws which govern the activities of these higher complexities of matter might have been formulated in advance, as corollaries from the fundamental causal principles. This remains for future experiment and logic to settle. What I wish to point out this afternoon is that the advent of the organism and its evolution have apparently given rise to two new principles of activity in the universe—principles which, so far as I can see, are not in any way deducible from the universal laws of causation. To this extent the conception of emergent evolution seems justified.

The various laws of cause and effect, so far as they have been discovered and formulated to-day, may be summed up, I take it, under the general principle of the conservation of energy. This principle is by no means self-evident. To the casual observer every activity requires expenditure of energy; in other words, work or effort seems at first sight to involve the disappearance of a certain amount of energy. It required the most delicate experimentation to demonstrate that the energy in question is not actually lost, but is merely transformed. However, the truth of the principle of conservation seems now well established. The total effect is believed to be exactly equivalent to the sum total of the causes; in every change that occurs, the total consequents are exactly equal to the total antecedents. This principle might appropriately be termed the law of the unvarying total.

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[1] Address of the retiring vice-president and chairman of Section I—Psychology, American Association for the Advancement of Science, Des Moines, December, 1929.

My objection to vitalistic and teleological theories is that they seem to assume exceptions to this general causal principle. Their line of argument, so far as I am able to analyze it, seems to imply that in the organic world certain phenomena of growth and behavior involve changes in which the total later state is more than or essentially different from the totality of its antecedents. In fact, vitalistic biology and purposive psychology seem to cast doubt on the *uniformity of nature*, which is perhaps more fundamental than the principle of conservation. I shall not go into this question, which is really aside from our present topic. What I wish to bring out is that one may adopt a thoroughly mechanistic view of the world, which holds that the principle of the unvarying total is without exception, and at the same time believe that certain new principles of activity operate in connection with organic life.

The first of these supplementary principles is that of natural selection. There is nothing in the operation of natural selection that involves any exception to the universal causal principle. The changes that occur in connection with the growth of the individual organism and the changes of type which mark the evolution of species may all be brought under the principle of the unvarying total. And yet something new does occur in evolution. Organisms tend to become more adapted to the conditions of their environment: they respond to a larger number of stimuli; their responsive activities tend to afford them more and better assistance in keeping alive, in maintaining their status as organic units and in utilizing the surrounding world for their own welfare. Every step in progressive evolution proceeds, I take it, strictly according to the causal principle. At the same time, this process (or fact) of increasing adaptation is something quite novel: it does not occur—it has no meaning whatever—except in connection with those peculiar groupings of molecules which we call organisms.

Natural selection means simply that the fittest organisms tend to survive. They survive because they are more adapted to the general environment than other organisms. The principle is almost tautological. But could it operate in connection with any material except the biological organism or some unitary system which possesses the essential characteristics of the biological organism?

Selective evolution requires the continual production of complex individuals which resemble one another. It requires also that these individuals shall differ to some extent from one another. These conditions are fully met in biological organisms through their specific mode of reproduction. Since the offspring bear a close resemblance to the parent stock, the same types of organs and the same modes of behavior reappear generation after generation. Since the offspring differ in certain respects from the parents, there is opportunity for selective improvement in any of these organs and modes of behavior. It would be assuming too much to say that nowhere in the universe does selective evolution occur except among organisms such as exist on the earth. Other systems which fulfil these essential conditions may have been built up in other ways and out of other chemical elements on other planets. My point is that these conditions do not exist below the organic level. The principle of selective adaptation would seem to be a brand-new mode of activity, which does not operate in simple aggregations of matter or in any of the simpler systems of chemical compounds.

Let me apologize for presenting to this audience a form of argument which smacks of the philosopher rather than the scientist. My excuse is that the doctrine of emergent evolution itself is a philosopher's view of the world and has been bolstered up chiefly by philosophical evidence. The mechanist suspects, though he may not be able to prove, that the so-called new properties which emerge in new compounds and new systems are not really novel. Given sufficient knowledge of elementary properties, I believe that the properties of the higher compounds could be predicted—in other words, that the higher laws which we formulate with respect to their activities are merely corollaries from the fundamental principle of causation. But the principle of natural selection, or selective adaptation, does not seem to be in any sense a corollary from the causal principle.

It is perhaps unnecessary to-day to emphasize the importance of selective adaptation in promoting organic evolution. Through its means the organization of matter takes an entirely new trend. Spencer's mechanistic formula for evolution may cover the progressive changes of cosmic phenomena in general, but it proves inadequate to express the full import of organic evolution or the results that attend the interplay between organisms and their environment. The evolution of special organs for nutrition, circulation, responsive activity, reproduction, defense, social communication between organisms, introduces a novel feature into the material world. This new trend, according to the mechanist, represents no exception to the general principle of causation—it involves no modification of that principle. But it does indicate the operation of an additional principle, that of natural selection. In the jargon of the logician, the principle of selective adaptation may be said to be superimposed upon the principle of the unvarying total.

Of what interest is this to us as psychologists? It seems to bear on our branch in two important ways. In the first place, selective adaptation enables us to understand the evolution of behavior. Response to stimulation is an indirect reaction. In addition to the direct and immediate physical action-and-reaction which occurs when a force is applied to a body, we observe in the case of organisms a secondary and later reaction which takes place when the given force is applied as a stimulus to a receptor organ. And we note that this indirect reaction or response tends to be adaptive—it serves in most cases to promote the organic welfare of the creature. These adaptive responses depend upon the presence in the organism of certain specific organs for reception and for motor activity, and of a conducting system for establishing proper connections between these two groups of organs. The evolution of this entire behavior mechanism depends upon natural selection. It follows, then, that the real meaning of responsive behavior is bound up in the operation of selective adaptation, so that this principle concerns us fully as much as it does the biologists.

The second point of interest to psychologists lies in the fact that the selective principle does not complete our explanatory theory. I shall try to show that a still higher principle becomes effective in the later stages of organic evolution. In the more advanced animal species behavior may be a response not merely to present stimulation but to future situations. The phenomenon of anticipation or foresight is, to all appearances, something novel, which occurs only in organisms of a certain degree of complexity. The frog that snaps at a fly, the squirrel that buries a store of nuts and later retrieves them, the man who builds and furnishes a home for a prospective bride—all these are responding in a measure to future situations. A large part of human behavior has more or less definite reference to the future, and one could cite a host of such instances in subhuman species. The fact that responses are made in anticipation of future conditions is responsible for the rise of the teleological school of psychologists, which may be regarded as the counterpart of the vitalistic school in biology.

Now just as the evolution of organisms seems to admit of explanation on the basis of mechanistic causation, so the evolution of anticipatory responses and their mode of operation seems explicable in terms of the same general causal principle. But the anticipatory type of response depends upon certain special factors and conditions which come into play only in the higher organisms. In these higher species certain organs and mechanisms have evolved which enable them to respond in a preparatory way to stimuli which have not yet been applied and to situations which are still forming. Distance reception is one of these factors. The distance receptors enable a creature to see, hear or smell an object which is not in immediate contact with his body. If the object is approaching him, he may respond to the visual, auditory or olfactory stimuli in such a way as to be prepared for the contact of the object when it finally impinges upon his body. Furthermore, if the object happens to be a nutritious substance he may respond by locomotor activity, and hasten the advent of the tactual and gustatory stimuli by moving toward it. Or if the object is something injurious he may act so as to prevent the contact stimulus altogether.

Another factor which promotes anticipatory responses is the more or less permanent registration of the effects of past experiences in the nervous system. We are still in doubt as to the physiological mechanism of this registration. But the fact itself is perfectly evident. And it has this result. When a situation occurs which resembles a situation that the animal has previously experienced, the earlier response may be carried out more quickly and more precisely than it would if the situation were new. Not only this, but in many cases of repeated behavior the motor activity which takes place is a response to a phase of the situation which followed somewhat later on the previous occasion. Classical examples of this are the burnt child who withdraws his finger before actually touching the candle flame; and the bird who, after escaping from the trap, responds to similar baited objects by flying away. The literature of conditioned reflex experimentation is filled with examples of the effects of neural registration. In almost every case the result of conditioning is an anticipatory or at least a preparatory response. And whenever we examine the process by which these preparatory responses are acquired and trace the details of their operation, we find no indication of any modification of the causal principle—no exception to the principle of the unvarying total. In every case the movements and changes that occur are just what the physicist and chemist could have predicted, if they had had knowledge of all the immediate antecedents.

The teleologist, it should be noted, ascribes the fitness of anticipatory responses to a certain peculiar characteristic of consciousness which he calls awareness or insight or realization of the situation. But in practical experience we find that this awareness or insight has no power whatever to initiate the appropriate motor response unless the requisite neural connections are already established. If a man, by taking thought, can not oscillate his own ears, how can conscious reflection enable him to perform more complicated acts unless the proper neural connections are established? Conscious foresight, taken by itself, seems incapable of explaining anticipatory responses. The principles of causation and selection, exemplified here in the learning process, furnish the basis for an adequate explanation. The teleological theory, then, seems to violate the canon of parsimony. It multiplies causes and agencies beyond our need.

And yet if we wish to understand these anticipatory phenomena completely, we must look beyond mere causation and adaptation. There is something further to be considered. We have not fathomed the entire significance of the phenomena when we have traced the evolution of the organs and their functions. Anticipation of the future is a fact which demands recognition. It does not seem to be in any way implied in natural selection, though it obviously depends upon the operation of that principle. Anticipatory adjustment is a novel type of response which is observed in certain highly complex organisms. The full meaning of their behavior is realized by the observer only if he recognizes that certain of their activities are more than mere responses to present stimulation.

Recently a tornado was reported in the Caribbean Sea moving in the direction of Florida. Preparations were made at once to prevent loss of life and minimize the damage to property. Ships altered their course. Buildings were shored up. Dwellers in the Everglades were transferred to more elevated ground. All these human activities were in response to what stimuli? In a measure they were reactions to present verbal stimuli—telegrams, storm signals, newspaper bulletins, radio messages, individual warnings by word of mouth. I have no doubt but that if a super-scientist were to trace the cause-and-effect relations of this series of responses in the case of any person involved, he would find that the fundamental causal principle accounted fully for that person's activity. But this causal explanation does not exhaust the meaning of the behavior. The activity of some thousands of individuals in this instance had reference to a certain future situation as well as to the present. As a matter of fact, in cases like this the immediate antecedents (the verbal stimuli) may be regarded as merely incidental—the responses were primarily to stimuli which were yet to come.

A large part of human behavior is of this anticipatory type. In the majority of cases it may properly be called purposive, since the responsive activity is generally preceded by some conscious picture or imaging of the prospective situation. But we need not regard conscious purpose as a distinct type of preparatory response. It is merely more complex and more adaptive. In simpler instances, especially among subhuman species, the same type of response may occur without any prevision; the present stimulus serves to set off the response, and yet the response is obviously with reference to some future situation. The action of a dog in burying a bone is an example of this, or the act of a baseball fielder in raising his hands to catch a high fly. Either of these responses may occur without any conscious foresight. The conscious representation of the coming situation seems to involve merely the operation of a more highly organized neural adjustment, which is of the same anticipatory type as automatic preparatory adjustments. The significance of all such acts, whether consciously purposive or not, lies in the fact that they are preparatory responses. Are we not justified, then, in regarding anticipatory adjustment as a new principle of activity, which appears at a certain stage of organic evolution and supplements the principle of selective adaptation?

And now let me explain my reasons for discussing this topic. I have no idea of expounding a cosmic theory or a philosophic system. But I do feel that the theoretical implications of the evolutionary process fully deserve the attention they have received. The theory of vitalism in biology and the teleological or hormic theory in psychology are attempts to provide a suitable explanation of the progress of organic evolution. The more recent theory of emergent evolution is an attempt in the same direction. It is reasonable to ask whether any or all of these views are correct interpretations of the course of evolution. Since these views all hinge directly upon one's interpretation of the causal process, the problem of the causal relation must first be considered. Until recently the principle of conservation was by no means established. Transformations and inconsequences which to-day we would call magical were conceived as possible and were assumed as actually occurring. These magical interpretations of the causal process have now been abandoned by thinking men. The principle of the unvarying total is accepted as a general characteristic of the changes that take place in physical and chemical groupings.

The status of organic phenomena is not so well established. Vital force and purposive striving are accepted to-day by a number of biologists and psychologists in good standing. These views can be refuted only if we are able to show that the course of evolution can be fully explained in terms of mechanistic processes. Nor can they properly be characterized as magical or mystical unless we are able to demonstrate that a non-mechanistic explanation involves some exception to the causal principle of the unvarying total. I see no clear evidence at present that either of these theories involves magical or mystical assumptions. But I do believe we have considerable evidence for a thoroughly mechanistic interpretation of life and mind.

The process of natural selection seems able to account in a purely mechanistic way for the progressive trend of organic evolution toward greater adaptiveness of structure and function. We need not assume that a new type of energy, a vital force or entelechy, appears in the universe when organisms come into existence. The age-long causal principles still hold in the organic realm. But we may properly concede this much to the vitalists—they are right in suggesting that we must seek a new and broader view-point when we come to deal with organic phenomena. The organism may well be regarded as a new kind of system, whose distinctive characteristic is an ability to maintain its organic unity through dynamic interplay with the environment. The inherited similarity among organisms, and their variability, taken together, give rise to natural selection. And the result of the selective process is to improve the relations between the organism and its environment. Natural selection therefore should be considered not merely as a process, but as bringing about a very definite end-result: adaptation. The process of selective adaptation, then, should be recognized as a new factor which appears in connection with organic life. It is in no sense an exception to the causal principle of the unvarying total, but it does supplement this principle. It would appear impossible to have predicted in preorganic ages, from any knowledge of causal principles, the extraordinary variety and complexity of the organisms that have actually arisen, their manifold activities and tenacity of existence, or their numerical abundance. The principle of selective adaptation seems capable of accounting for all these facts. It explains the course of organic evolution without assuming the advent of a new kind of energy to operate these changes.

The same line of argument may be applied to the teleological psychology. This theory is useful in suggesting that a new and broader view-point is required when we come to deal with the phenomena of anticipatory behavior and prevision. But the assumption of a new kind of force to account for these activities seems needless and redundant. The universal causal principle and the principle of selective adaptation seem sufficient to explain the rise of preparatory responses and conscious purpose. The processes by which organic beings act with reference to future stimuli and coming situations may be described in purely mechanistic terms. But the significance of these phenomena must be sought in something that lies beyond these fundamental principles: their real meaning is summed up in the principle of anticipatory adjustment. There is no novelty involved in this principle, except that we have adopted a broader view-point.

And now we have reached the point where we can appraise the truth and error in the doctrine of emergent evolution. Many, if not all, of the so-called emerging properties which appear in the higher aggregations of matter could be predicted, I believe, from an intimate knowledge of physical principles. They are not really novel. They emerge only as new groupings or systems come into being. But we do find two new kinds of process developing at certain stages of evolution on the earth. With the advent of organic life the trend of progress is determined by the principle of *selective adaptation,* which seems to be a distinct novelty and not a mere corollary from the general principles of physics. At a later stage the responsive behavior of certain organisms to forces and situations in the environment is determined in part by a second novel principle—that of *anticipatory adjustment*—which assumes enormous importance in human life. These two principles, based upon the fundamental causal principle of the *unvarying total,* form a hierarchy. I believe they are needed to account fully for the organic stages of evolutionary progress. At least they lend new significance to this unique development. If the doctrine of emergent evolution means the recognition of general principles such as these, I believe it can be defended. If it means that new properties appear with the formation of new aggregations of matter, it is either a truism or it is open to grave question as implying an exception to the general uniformity of nature.

SCIENTIFIC EVENTS

THE WORLD PRODUCTION OF GOLD

SINCE the discovery of America, world production of gold has only slightly exceeded a billion ounces, approximately 1,003,500,000 ounces being indicated by study of available records, according to an economic review of gold production in the period 1493–1927, recently concluded by Robert A. Ridgway and the staff of the common metals division of the U. S. Bureau of Mines. Scattered production, of which there is no record, would probably add no more than one per cent. to this estimated total.

Mr. Scott Turner, director of the bureau, points out that more than half the grand total of gold production for the past 435 years, or 516,273,000 ounces, was produced in the first 27 years of the present century. Of the cumulative world production of gold since 1492, 467,000,000 ounces are estimated to exist in the form of monetary stocks, while 536,563,329 ounces represent the balance of gold lost or absorbed in other than monetary uses.

The scarcity of gold may be illustrated by the fact that if the entire world production since the discovery of America were cast into a cube its edges would measure only 38.5 feet. It might well be questioned whether this gold, considered merely as a metal characterized by certain properties, could be worth the toil and sacrifice required for its production; but as a basis of exchange, greatly facilitating the development of commerce among the peoples of the earth, its value to civilization exceeds all reckoning.

In spite of a superficial claim often made that gold does not pay its cost of production, it can hardly be doubted that United States gold production, amounting to more than $4,500,000,000 when reckoned roughly at $20 an ounce, must have been an important factor in assisting the development of other sources of national wealth. The British Empire production from the Transvaal (1901 to 1927), of more than 198,000,000 ounces; from Australasia, of more than 168,000,000 ounces; from Canada, of nearly 32,000,000 ounces; from India and Rhodesia, together, 32,000,000 ounces; and from other parts of the British Empire, of 12,000,000 ounces, amounting in all, since 1801, to 442,994,369 ounces, or about $9,000,000,000, should be reckoned an important factor in the prosperity of that empire.

During the first half of the nineteenth century nearly three times as much gold was produced in the fifth decade as in the first; yet the production of the first decade of the next half century was almost four times that of the preceding decade and nearly twice that of the first half of the nineteenth century. A gradual decline is noted during this half century up to the last decade, which showed an increase of 94 per cent. over the preceding decade. During the last half of the nineteenth century nine times as much gold was produced as during the first half. During the first decade of the twentieth century the average annual production increased over 8,000,000 ounces, or 81 per cent., over the preceding decade's production. The second decade showed an increase in average annual production of over 2,000,000 ounces, or 12 per cent., more than during the first decade.

In the world production of gold from 1493 to 1927, North America was the largest producing continent, contributing 281,056,639 ounces, or 28 per cent., with Africa a close second, contributing 270,127,146 ounces, or 27 per cent., of the world total. Australasia produced nearly 169,000,000 ounces, or 17 per cent.; South America nearly 125,000,000 ounces, or 12 per cent.; Asia 112,000,000 ounces, or 11 per cent., and Europe nearly 44,000,000 ounces, or 4 per cent.

THE ANNUAL EXHIBITION OF THE BRITISH PHYSICAL AND OPTICAL SOCIETIES

THE twentieth annual exhibition of the Physical and Optical Societies opened on January 7 at the Imperial College of Science and Technology, South Kensington.

The London *Times* gave the following description of the exhibition: There were two main sections devoted respectively to trade exhibits of electrical, optical and other physical apparatus, and to research and experiment, and smaller sections showing apparatus used for the teaching of physics in schools and universities, a group of historical exhibits and competitive exhibits made by apprentices and learners. The last of these was introduced this year for the first time. It is realized that scientific instruments are now used so extensively that the makers have had to turn to methods of mass production. No one man to-day makes a complete instrument, and there is a danger of skilled craftsmanship dying out. The new section had for its object the encouragement of craftsmanship, and the display represented the individual work of apprentices and learners employed by scientific instrument manufacturers who took part in the exhibition. The two classes included practical examples of electrical, optical, engineering and metal work, tool-making and pattern-making, and examples of designs, drawings or tracings for scientific instruments. Eight prizes were offered, and there were 50 entries.

All the leading makers of instruments and accessories contributed to the trade section, and the exhibits covered a very wide range. There were cameras and lenses, valves, microphones, thermometers, meters of many specialized types, accumulators, timing mechanisms, spectrographs, magnetic compasses, echo sounding machines, aircraft direction finders, a tobacco moisture tester, binoculars, telescopes, rain gauges, theodolites, electric furnaces and scores of other instruments and machines.

The research and experimental section was particularly attractive, though it is hoped that in future years its scope and utility will be further extended by the cooperation of fellows of the societies and others who may be able to contribute. Government institutions, such as the National Physical Laboratory, and the Royal Air Force Establishment, South Farnborough, sent exhibits. From the laboratory came a distant reading resistance thermometer outfit for cold storage work, experimental transmitting and receiving apparatus for ultra-short waves, apparatus for the measurement of the over-all performance of radio receivers and a method for indicating turbulence in airflow.

Exhibits of the research laboratories of the Gramophone Company, Limited, and the Marconiphone Company, Limited, occupied a whole room. A model was shown of a photographic sound-recording system. The system comprises a glow lamp, the brilliance of which is modulated by speech currents from the studio microphone. A slit of light from this lamp, after traversing an optical system which reduces the image of the slit to the required dimensions, impinges on a reel of film and makes a record of the variable density type. Another H. M. V. exhibit showed a method of reproducing physically the conditions in record grooves of any desired type. The apparatus enables groove conditions to be magnified 400 times, and by its use the behavior of needles at various stages of wear and under any required groove conditions can be felt and examined at leisure. Among numerous exhibits from the research laboratories of the General Electric Company, Limited, was a model of a photo-electric street lighting unit, so designed that as daylight fails lamps are automatically illuminated. The apparatus is being tested practically in a street at Wembley. Another model illustrated a transmission tower testing plant for the load testing of overhead transmission of current—a topical exhibit in view of the proposals for the distribution of electricity by means of towers and cables. Other bodies represented in the section included the British Research Association for the Woollen and Worsted Industries, which has an instrument for measuring the thickness of fabrics, and the Gas Light and Coke Company, Limited.

The apparatus for the historical section of the exhibition was selected this year to illustrate experiments of historical importance on the determination of the mechanical equivalent of heat, and some points in the evolution of thermometers. The thermometers included reconstructions of the earliest known instruments for demonstrating the expansion of air by heat, the thermoscopes described by Philo of Byzantium (300 B. C.) and Hero of Alexandria. There was also a photograph of Galileo's thermoscope.

Three evening discourses were arranged in connection with the exhibition. Lord Rayleigh gave an address on "Iridescent colors in nature from the standpoint of physical optics"; Mr. S. G. Brown on "Gyro compasses for gunfire control," and Sir Ambrose Fleming on "The present and future of television."

THE FOREST SURVEY

THE U. S. Department of Agriculture has issued a statement announcing the promotion by the United States Forest Service of District Forester C. M. Granger, of the Pacific northwest district, to the position of head forest economist in charge of the nation-wide forest survey now being launched by the Forest Service.

The forest survey, authorized by the McSweeney-McNary Act of 1928, is one of the most important undertakings in the development of forestry thus far undertaken. It will be a comprehensive appraisal of existing forest supplies and conditions, growth and requirements, and of present and future trends, all of which, when properly coordinated, will constitute a fundamental and economically sound basis for determining federal, state and industrial forest policies and programs. Congress has authorized a federal contribution of $3,000,000 to the project. A small initial appropriation of $40,000 is available this year.

Success in developing the project will depend upon widespread cooperation with federal and state and industrial and other private agencies. Certain phases of the survey, such as the forest resource inventory and the study of growth, will be handled by the regional forest experiment stations under the general direction of Mr. Granger.

Because of its outstandingly complex and important forest problems, the Pacific northwest has been selected as the region for the beginning of intensive work. The Pacific northwest forest experiment station, of which T. T. Munger is director, has already commenced preliminary work. The study will be extended as rapidly as possible to other forest regions, and will eventually cover the entire United States.

Another step already taken is a canvass, in cooperation with the U. S. Bureau of the Census, of the wood requirements of the wood-using industries, as a part of the present and future wood requirements phase of the survey. Advance cooperative work also is being initiated in the Lake States region.

The agricultural appropriation bill now before the Congress carries an increase of $85,000 for the forest survey for the next fiscal year. It is planned to use $50,000 of this to expand the work in the Pacific northwest, $25,000 to initiate intensive work in the southern hardwood region and $10,000 for individual assignments.

Mr. Granger is a graduate in forestry of Michigan Agricultural College. He entered the Forest Service in 1907, serving successively as deputy supervisor, supervisor, and assistant district forester in charge of the offices of silviculture and of operation in the Rocky Mountain district. During the war he served with the Tenth Forestry Engineers, attaining the rank of major. In 1924 he became district forester of the Pacific northwest district. He will enter his new work with a wide experience in the development of silvicultural policies, management plans, fire protection plans and with a comprehensive understanding of the economic aspect of forestry.

Mr. Granger assumes his new duties immediately, with headquarters temporarily in Portland, Oregon.

The Forest Service also announces the appointment of Horace J. Andrews as senior forest economist, to become regional project leader for the Pacific northwest. Mr. Andrews is a graduate of the University of Michigan and received the M.S. degree in forestry from that institution in 1916. He was formerly employed in the U. S. Forest Service, and later engaged in private forestry work and in teaching at three forest schools. He was closely associated with the development of the Michigan land economic survey, and more recently has been in charge of the divisions of protection and lands in the Michigan department of conservation.

RADIO TALKS ON SCIENCE IN THE KITCHEN

EACH year since 1925 Mellon Institute of Industrial Research has been giving a series of radio talks, broadcast from the University of Pittsburgh Studio of the Westinghouse Electric & Manufacturing Company's Station KDKA. Each of the five series presented so far has been published in booklet form; three of these publications are really text-books of home economics and, in fact, are being widely used in domestic science courses.

In order to supplement these series of talks, the Mellon Institute has decided to schedule eight radio discourses on "Science in the Kitchen," on the Fridays of February and March, at 5:45 P. M., from the University of Pittsburgh Studio of Station KDKA. They will subsequently be published by the university. In general, the new series will relate to the selection, care and service of foods, and each talk will be given by a research specialist of the institute.

The complete program is as follows:

Date in 1930	Subject	Speaker
Feb. 7	"The Well Planned Kitchen"	Dr. Geo. D. Beal
Feb. 14	"The Intelligent Purchasing of Foods"	Dr. W. W. Duecker
Feb. 21	"The Care of Food in the Home"	Dr. E. W. Morrison
Feb. 28	"Good Proportions of Foods"	Dr. G. J. Cox
Mar. 7	"The Uses of Milk in the Home"	Dr. L. W. Bass
Mar. 14	"Good Meals by the Young Homemaker"	Mr. E. R. Harding
Mar. 21	"Food for Young Children"	Dr. R. N. Wenzel
Mar. 28	"School Lunches"	Dr. R. F. Beard

ANNUAL REPORT OF THE YALE SCHOOL OF MEDICINE

TRAINING of physicians and humanitarians, rather than doctor-technicians, is described as the prime objective of the Yale School of Medicine, in the annual report of Dean M. C. Winternitz to the president and fellows of Yale University. Such an aim is said to necessitate the study of man in his entirety, and great strides in the direction of making this possible were taken during the past year. Of first importance was the formation of the Human Welfare Group, with the Institute of Human Relations as the integrating agent, bringing into close contact various university divisions engaged in the study of individual and social conduct.

Gifts equivalent to $9,900,000 were obtained by the university during the year to meet financial requirements aggregating $15,500,000 for the stabilization of the activities of the group. Most of the gifts were designated for the work of the Institute of Human Relations. There was also included, however, the sum of $2,000,000 for erection of a clinic building and the medical and pediatrics laboratory on the grounds of the New Haven Hospital, and construction of these units is well under way.

During 1929, the Farnam Memorial Building, Lauder Hall and the Brady Memorial Laboratory, on the hospital grounds, were completed at a cost of $1,250,000, and the Raleigh Fitkin Memorial Pavilion for children, to cost $600,000, is nearly ready for occupancy.

With this progress in building construction have gone developments which will enable the Yale School of Medicine better to take its part in forwarding the plan for studying man from the mental, social and physical point of view. The work in psychiatry and mental hygiene has been strengthened both by additions of personnel in the fundamental sciences underlying study of the mind, and by adding representatives of the various aspects of treatment and prevention of mental disease. A number of appointments were made following Dr. Winternitz's visit last spring to the European clinics for the study of the central nervous system.

Not only is the mind to be taken into consideration by the Yale School of Medicine in dealing with all its problems of health, but economic and social factors as well, the study of these latter factors to be furthered by cooperation, through the Institute of Human Relations, with the university divisions of the social sciences. Furthermore, the School of Medicine is to devote its attention not alone to the sick in mind and body, but also to the well, with the aim of keeping people from getting sick. The report says:

> Not only is the negative side of well-being important, but the positive must also be understood. Furthermore, no one is so efficient that further assistance in one or another direction might not be advantageous. Too long has

all energy, almost, been directed toward the totally weak; too long have the strong been unaided—indeed, without consideration.

That the two great fields, the physical and the psychic, can not be sharply differentiated is obvious to every thinking person, especially, perhaps, to the physician who constantly is made conscious of the influence of physical illness on the psychic reaction of his patient. The more discerning recognize the contrary condition; they observe the influences of psychic disturbances, originating in social, economic and a vast number of other factors, upon the patient's physical reactions.

SCIENTIFIC NOTES AND NEWS

Dr. John Dewey, professor of philosophy at Columbia University, will be the first William James lecturer at Harvard University on the foundation provided by the late Edgar Pierce, of the class of 1892, who at one time held a position in psychology at Harvard. Professor Dewey will give during the second half of the next academic year a series of ten public lectures and will conduct a seminar for graduate students in philosophy.

Dr. Richard Mills Pearce, Jr., general director of the division of medical education at the Rockefeller Foundation, formerly professor of medical research in the University of Pennsylvania, died suddenly on February 16, at the age of fifty-five years.

Dr. William Royal Stokes, bacteriologist of Baltimore, who handled some of the first infected parrots, has given his life in the battle with parrot fever, as did Harry B. Anderson, laboratory assistant at the U. S. Hygienic Laboratory. Dr. Daniel S. Hatfield, of Baltimore, and Dr. Charles Armstrong, of the U. S. Public Health Service, are both suffering from the disease, but their recovery is expected.

The William H. Nichols Medal of the New York section of the American Chemical Society for 1930 has been awarded to Dr. Samuel Edward Sheppard, assistant director of the research department of the Eastman Kodak Company, Rochester. The award, bestowed for outstanding achievement in the chemistry of photography, will be presented to Dr. Sheppard at a joint meeting of the American Chemical Society, the Society of Chemical Industry, the Société de Chimie Industrielle and the American Electrochemical Society to be held on March 14 at the Chemists' Club, New York City. Dr. Sheppard will deliver an address on "The Reactions of Photographic Material to Light." Dr. C. E. K. Mees, director of research of the Eastman Kodak Company, will speak on "The Accomplishments of the Medalist," and Dr. Wilder D. Bancroft, of Cornell University, on "A Futuristic Study of the Medalist."

The Lamme Medal of the American Institute of Electrical Engineers has been awarded to R. E. Hellmund, East Pittsburgh, Pennsylvania, "for his contributions to the design and development of rotating electrical machinery." It is expected that the medal will be presented at the summer convention of the institute, which is to be held in Toronto, Canada, from June 23 to 27.

The Harrison Memorial Prize Selection Committee, consisting of the presidents of the Chemical Society, the Institute of Chemistry of Great Britain and Ireland, the Society of Chemical Industry and the Pharmaceutical Society has awarded the Harrison Memorial prize for 1929 to Dr. R. P. Linstead. The prize is given for conspicuously meritorious work in any branch of chemistry, pure or applied, and is to be regarded as an exceptional distinction to be conferred upon a chemist less than thirty years of age.

Dr. O. E. Jennings, head of the department of botany of the University of Pittsburgh and curator of botany and director of education at the Carnegie Museum, received the honorary degree of doctor of science at the convocation of the University of Pittsburgh in February.

Dr. P. S. Selwyn-Clarke has received the decoration of the Médaille d'Argent des Epidémies from the French government for services in connection with the outbreak of yellow fever in West Africa.

Dr. A. Fujinami, professor of pathology in the Kyoto Imperial University, became a member of the Imperial Japanese Academy of Science at a recent general meeting of the academy.

Dr. Donald F. Jones, geneticist, of the Connecticut Agricultural Experiment Station at New Haven, has been named chairman of the publications committee of the Sixth International Genetics Congress to be held at Cornell University in 1933.

Dr. O. L. Sponsler, professor of botany in the University of California at Los Angeles, has been chosen president of the Western Society of Naturalists.

As has been reported in Science, the meeting of the British Association this year will be held in Bristol, from September 3 to 10, when Sir Thomas Holland will be succeeded in the presidential chair by Professor F. O. Bower. The newly elected presidents of the sections are announced in *Nature* to be as follows: A—Mathematical and Physical Sciences, Dr. F. E. Smith; B—Chemistry, Professor G. T. Morgan; C—Geology, Professor O. T. Jones; D—Zoology, Dr.

W. T. Calman; E—Geography, Professor P. M. Roxby; F—Economics, Professor T. E. Gregory; G—Engineering, Sir Ernest Moir; H—Anthropology, Dr. H. S. Harrison; I—Physiology, Professor H. S. Raper; J—Psychology, Professor C. W. Valentine; K—Botany, Dr. A. W. Hill; L—Education, Right Honorable Lord Eustace Percy, P.C.; M—Agriculture, Dr. P. J. du Toit.

PROFESSOR ARTHUR E. KENNELLY, since 1902 professor of electrical engineering at Harvard University, retires at the close of the academic year with the title of professor emeritus.

DR. WILLIAM B. CASTLE has been promoted to be assistant professor of medicine in the Harvard Medical School, not assistant professor of physiology as was stated in a recent number of SCIENCE.

THOMAS D. BURLEIGH, of Georgia, for the last nine years head of the division of forestry of the Georgia State College of Agriculture and previous to that time a technical field assistant in the U. S. Forest Service, has been appointed associate biologist in the Bureau of Biological Survey to carry on research work on the relation of wild life to forests authorized by the recently enacted McSweeney-McNary Forestry Research Act. He will be stationed at the Appalachian Forest Experiment Station at Asheville, North Carolina.

DR. E. P. CLARK, research chemist of the Interstate Cottonseed Crushers' Association, and Dr. Herbert L. J. Haller, associate in the department of chemistry of the Rockefeller Institute for Medical Research, have accepted appointment in the insecticide division of the chemical and technological research unit of the Bureau of Chemistry and Soils.

ASSOCIATE STATE FORESTER WILLIS M. BAKER, of the New Jersey Department of Conservation, has been appointed director of the newly created Pennsylvania Forest Research Institute at Mont Alto. This is the first institute of its kind maintained by a state department of forestry in the United States.

ASSOCIATE DEAN COLLINS P. BLISS has been named dean of the college of engineering of New York University to succeed Dean Charles H. Snow, the retiring administrative head of the college.

DR. SHIRLEY W. WYNNE, New York City health commissioner, has been appointed professor of preventive medicine at the New York Polyclinic Medical School and Hospital.

THE Royal Society has awarded a Foulerton research studentship to Dr. A. S. Parkes, who at present holds a Beit research fellowship. Dr. Parkes is working in the department of physiology and biochemistry at University College, London.

DR. J. G. DUSSER DE BARENNE, of the University of Utrecht, has been appointed professor of physiology at Yale University. Dr. Eugen Kahn, of the University of Munich, has been appointed professor of psychiatry.

K. Y. WANG, who graduated in agriculture at Purdue University in 1928 and obtained his master's degree in August, 1928, has been appointed president of Kiangsi Agricultural College in Nanchang, Kiangsi, China.

THE following appointments, recently made by the British secretary of state for the colonies, are recorded in *Nature:* Mr. A. G. G. Hill, botanist, Nigeria, to be plant breeding officer (senior geneticist), Mauritius; Mr. N. Humphrey, to be agricultural officer, Kenya; Mr. L. R. Doughty, to be geneticist, East African Agricultural Research Station, Amani, Tanganyika Territory; Mr. J. P. Mead, personal assistant to the conservator of forests, Malaya, to be director of forestry, Malaya; Mr. J. N. Oliphant, conservator of forests, British Honduras, to be deputy director of forestry, Malaya.

DR. D. L. EDSALL, dean of the Harvard Medical School and dean of the School of Public Health, has a leave of absence from May 1 to commencement and for the first half of 1930–31. He will use his sabbatical leave in travel and research abroad. During his absence, Dr. C. K. Drinker has been appointed acting dean of the School of Public Health, and Dr. Worth Hale will serve as acting dean of the Medical School.

DR. KONSTANTIN ECONOMO, professor of psychiatry and neurology in Vienna, has been invited to lecture at Columbia University on his researches on the brain.

DR. L. W. NORDHEIM, of the University of Göttingen, has been appointed visiting professor of theoretical physics at the Ohio State University for the spring quarter. He will lecture on recent developments in wave mechanics.

PROFESSOR ERNEST L. SCOTT, of the department of physiology of the College of Physicians and Surgeons, Columbia University, spent December and January at the School of Tropical Medicine at San Juan, Porto Rico. On January 14 he gave an address before the faculty and students on "Blood Sugar." Colonel Edward B. Vedder, U. S. Army School, arrived on January 20. Colonel Vedder was a visiting lecturer this year. He gave four lectures before the faculty and students.

PROFESSOR BRISTOW ADAMS, of the office of publication of the New York State College of Agriculture, who has leave of absence, left at the end of the term to spend the equivalent term at the University of

Hawaii, Honolulu, to give two courses there, one on the conservation of natural resources and the other on journalistic writing. From Hawaii, which he will leave about the end of May, Professor Adams will visit Japan, China and the Philippines.

DR. GEORGE D. HUBBARD, head of the department of geology and geography in Oberlin College, will spend the coming college year in travel and study in Europe. His plans include visits to most of the countries of Europe and to Egypt, Syria and Palestine.

PROFESSOR C. T. BRUES, of Harvard University, delivered a series of two lectures on "Insects and Human Welfare" at Coker College on January 27 and 28.

PROFESSOR CHARLES J. CHAMBERLAIN, of the botanical department of the University of Chicago, will conduct a lecture course at the University of California at Los Angeles during the coming spring semester.

DR. E. P. WIGHTMAN, a member of the Research Laboratory of the Eastman Kodak Company, gave an illustrated popular lecture on "How, Why and What is a Photograph" on February 13 before the Brooklyn Institute of Arts and Sciences. The lecture included motion pictures, showing the development of a photographic negative, and motion-picture photomicrographs illustrating the action of various photographic developers on individual grains of silver helide.

DR. H. H. LOVE, of Cornell University, gave the first series of lectures under the Frank Azor Spragg Memorial Fund from January 27 to 31 at the Michigan State College. The fund is in honor of Professor F. A. Spragg, who was one of the first men employed by an agricultural experiment station to devote his entire time to plant breeding. He began his work with the Michigan Experiment Station in 1906, and continued with that institution until his death in 1924. The most prominent varieties developed by him are: Hardigan alfalfa, Robust beans, Michigan Black Barbless barley, Wolverine and Worthy oats, Rosen rye and Red Rock wheat.

THE seventy-ninth meeting of the American Chemical Society will be held in Atlanta, Georgia, from April 7 to 11. A public address to the citizens of Atlanta entitled "Chemistry Comes South" will be made by Dr. Harrison E. Howe. The division of industrial and engineering chemistry has arranged a series of papers dealing with industrial and chemical processes as practiced in the south. The division of physical and inorganic chemistry has arranged a symposium on analytical chemistry which includes the following speakers and subjects: G. L. Clark, "X-Ray Analysis"; C. C. Nitchie, "Spectrographic Analysis"; C. W. Mason, "Microscopic Methods"; V. K. LaMer, "Modern Theories of Solutions"; D. A. MacInnes, "Potentiometric Methods for H-Ion Concentration"; H. B. Weiser, "Colloid Chemistry in Analytical Chemistry."

THE American Institute of New York held its annual election on February 13, after a long contest concerning the policies of the institute. The progressive ticket won over the conservative by a majority of fifty-five votes, and the following officers were elected: *President,* Mr. A. Cressy Morrison, of the Union Carbide Company; *Vice-president,* Dr. Otis W. Caldwell, director of the institute of school experimentation, Columbia University; *Secretary,* Dr. William Crocker, director of the Boyce Thompson Institute for Plant Research; *Treasurer,* Alfred Knight, vice-president of Standard Brands, Inc.; *Trustees,* Dr. Oscar Riddle, Dr. H. H. Sheldon, Dr. Charles H. Herty, Walter Kutzleb, Fred M. Becker, Maurice Holland, Justus Ruperti, H. T. Newcomb, Willis H. Carrier.

THE United States Civil Service Commission announces examinations for physicist, $3,800 a year; associate physicist, $3,200 a year and assistant physicist, $2,600 a year in the Bureau of Standards. Applications for these positions must be on file with the Civil Service Commission, Washington, D. C., not later than August 14.

THE museum of the American Indian, Heye Foundation, has asked the Government of Denmark, through the State Department, for permission to send an expedition to Scoresby Sound and its vicinity in East Greenland to collect ethnological material for a study of the coast Eskimo of that region, as well as archeological specimens. Should permission be granted the expedition will be led by Captain Robert A. Bartlett, who during thirty-three years has made more than forty voyages to the Arctic.

DISCUSSION

ETHER STRUCTURE

STUDIES in recent years of the dielectric properties of gases and electrolytes show that electrical forces and inductions in such media depend upon the polarized ions or "dipoles" of the medium. Why not extend the same concepts to electrical forces and inductions across a vacuum, that is, through the ether? We must then conceive of the ether as a medium with a structure, that is, with "ether dipoles." By such a concept, we would obtain an explanation of "electric forces acting at a distance," something that has been very vague, or lacking, since the discard of the Maxwell ether displacement theory of electric charges and electric forces. The discovery of the electron disproved the ether displacement theory of electric charges, but it did not remove (for many physicists) the need of the ether concept in explaining electric waves, whether luminous or non-luminous. The actual structure of the ether will be a speculative problem until experiments have given us more facts in ether physics; but in view of the above, we can think of the ether as having an indefinitely large number of infinitesimal "ether dipoles." It is possible to think of these ether dipoles as ether concentration points, or some other hypothesis of their constitution may be assumed. Further, it may well be a question whether the ether is a continuous or a discontinuous medium. Indeed the quantum theory suggests the possibility of a discontinuous ether.

The "dipole ether hypothesis," while thus suggested by dielectric phenomena, should explain other phenomena if it is to gain acceptance. It seems to give a plausible explanation of the puzzle of how the electron can be at the same time a particle and a wave. A free electron, due to its electrical field, is surrounded by directed ether dipoles, an envelop of ether dipoles. The waves can be thought of as due to vibrations in this envelop of ether dipoles. The vibrations in the dipole envelop would arise from motions and changes of motions of the electron, these vibrations being transmitted to the surrounding ether atmosphere as waves. A free proton in motion, and possibly a moving atom, would also show wave characteristics for similar reasons.

We should also expect every material body to be surrounded by an atmosphere of ether dipoles, an atmosphere characteristic of the particular kind of matter. This follows of course from the fact that each kind of matter has its distinctive numbers of electrons and protons, and hence its field. We may find in these distinctive ether enveloping atmospheres possible explanations of various boundary electrical phenomena, such as electromotive forces of contact, electrosmosis, etc.

From the above, it is natural to ask about the possibilities of detecting ether structure by methods using X-rays or other short waves. The "grain" of ether structure may be too fine for ordinary X-ray methods, but there is always a possibility of some method giving results, and positive results would be important indeed for ether physics.

ALBERT P. CARMAN

JANUARY 8, 1930

AUDITORY NERVE IMPULSES

By placing an electrode on the cat's auditory nerve near the medulla, with a grounded electrode elsewhere on the body, and leading the action currents through an amplifier to a telephone receiver, the writers have found that sound stimuli applied to the ear of the animal are reproduced in the receiver with great fidelity. Speech is easily understandable. Simple tones, as from tuning forks, are received at frequencies which, so far as the observer can determine by ear, are identical with the original. Frequencies as high as 3,300 cycles per second are audible.

Numerous checks have been used to guard against the possibility of artifact. No response was obtained when the active electrode was placed on any other tissue. After destruction by pithing of the cochlea on the electrode side, the intensity of the response was diminished; after destruction of the cochlea on the other side as well, the response ceased. However, the possibility is still conceivable that these results are due to purely mechanical action of the nerve, which is brought about by mechanical vibrations transmitted from the cochlear structure acting as a special receptor and transmitter.

Further experiments are in progress.

ERNEST GLEN WEVER
CHARLES W. BRAY

PSYCHOLOGICAL LABORATORY,
PRINCETON UNIVERSITY

SCIENTIFIC NAMES

THE problem of scientific names, and it is no small one, has been brought to attention once more by Professor James G. Needham, of Cornell University,[1] some twenty years after an earlier presentation along similar lines. He certainly can not be accused of being precipitate or of lacking patience. His main plea in both cases is for something more workable. This latter communication was evidently stimulated by an extremely long and to our mind presumably distinctive generic combination, namely, *Brachyuropushkydermatogammarus*, and another nearly equally long name. The author of this generic term evidently failed to live up to possibilities or it might have been prefixed by any one of several very popular combinations such as *eu-*, *pseud-* or *acanth-*, the last permitting thirty-six letters in the name, and this could be increased considerably by combinations of two or three prefixes. In other words, there is no limit to this sort of multiplication, and if our little crayfish had several related genera, it would easily be possible to bring together an unrivaled assemblage of generic names which under present conditions would be handed down and presumably used by countless generations, provided writer's cramp did not incapacitate the scientists of the entire human race. The trouble with these extremely long generic terms is that they tell too much or take too long to tell it, just whichever way one pleases to regard it. If we could only take the *push* out of the generic name given above and devote the energy expressed by this four-lettered expressive combination to working out a more usable and really a more scientific nomenclature, the effort would not be in vain.

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[1] SCIENCE, 71: 26–28, 1930.

There are something over 160,000 zoological genera, and they are increasing at the rate of 1500 names a year, and most zoologists are firmly possessed of the idea that they are building up a permanent nomenclature. It is reasonable to believe that this manufacturing of generic names will continue for another series of years, possibly a hundred or more, and with this expected great increase in generic names having twenty-six to thirty or even more letters each, one may reasonably ask the question as to whether zoological nomenclature is likely to be the permanent structure so many desire. It requires no great mentality to believe that an exceedingly complex and increasingly cumbrous system is bound to break by its own weight and the pity of it all is that this is entirely unnecessary if we will but face the realities and carefully study the possibilities of systematic terms. The chemist discovered this years ago. Zoologists are certainly headed in that direction. There is no need of following the present nomenclatural highway until it disappears in a limitless morass.

Professor Needham suggests a backward step in the use of many of the older generic names in the earlier and broader interpretation. That may be preferable in some respects to the enormously multiplied genera we find in some groups to-day. It is, however, only a palliative, and we cannot expect to stem the taxonomic tide which would define more closely the systematic relations of the multitudinous forms grouped under zoology, to say nothing of those coming within the domain of botany. It is very desirable that the names in these two great groups should not be duplicated and that their formulation and application should be governed by the same general principles. Professor Needham also suggests enlisting the services of a psychologist in solving this problem. It is more than probable that the knowledge of an expert librarian would assist greatly. It certainly looks as though aid would be really needed from some source, and the writer is by no means certain that a very considerable service might not be obtained from the psychiatrist, since our system of zoological nomenclature, as it stands to-day, with all due respect to the unselfishness and conscientiousness of earlier workers, cannot by any stretch of the imagination be considered on the whole especially creditable to the intelligence and the acumen of scientists. One only needs to scrutinize a considerable list of generic names, 50,000 are better than 10,000, to arrive at the conclusion that there is much in formation and the assignment of these names which could be greatly bettered and the change would mean an immense increase in the efficiency of all subsequent scientific workers. Just a moment's consideration is sufficient to show that the use of thousands of several popular prefixes to differentiate between generic names can hardly be sustained on the basis that the prefix selected is really definitive. The present-day tendency is so strongly toward differentiation, partly forced by an indefensibly illogical, unwieldy system, that many generic names have little really definitive, and in many cases are to all intents and purposes meaningless combinations of letters, except as they arbitrarily express a taxonomic concept.

The system of Linnaeus was admirable for his day and generation and served its purpose for a long series of years. It does not follow, however, that a system devised then is equally satisfactory now any more than we would be willing to revert to sail, the canal-boat, and the ox-cart for transportation.

The scientific nomenclature of both animals and plants is, in our opinion, a matter of very great importance and one worthy of extended study not necessarily by men who have distinguished themselves as taxonomists, since the ability to interpret generic and specific differences does not necessarily imply an equal grasp of the complex problems involved in building up a workable or permanent or nearly permanent nomenclature. There should be some way devised, possibly through the good offices of the National Research Council, of bringing together a representative group of scientists for an exhaustive study of the problems of nomenclature. It is doubtful if the International Commission on Zoological Nomenclature would prove the best agency to handle such a general problem, though it has done much toward stabilizing nomenclatural practices. The project should be on a broad basis, biological in scope. The writer has in mind a fundamental study of the possibilities of using generic terms, letter combinations, or something of the kind in the development of a nearly automatic classifying system. There are great possibilities in some such arrangement. Anyone of several would greatly improve the heterogeneous combinations produced by the thousands to meet supposedly scientific necessities. Zoologists and botanists, biologists, if one prefers, are faced with a tremendous problem in classification and one destined to increase enormously as various groups are studied more closely. It is inescapable. The problem is akin to that of the librarian in charge of one of the largest libraries in the world. Experience has shown the latter that thirty-letter or thirty-numeral combinations are not necessary to the precise location of the million or more volumes in their charge. The same is true in regard to our hosts of generic names.

Primarily nomenclature is an aid to differentiation, the placing or locating of species. Generic names are not intellectual memorials of their originators. They are really tools for the correct placing of the multitude of interesting forms inhabiting the earth. The rule of priority was invoked in the interest of stability. Developments show gross carelessness in creating new names. We must face the facts and rise to the opportunity, not wait until overwhelmed by insurmountable obstacles. Does man exist for science or is science an aid to human understanding? It should be possible to secure a dispassionate, constructive survey of the entire nomenclatural situation by a body, not only capable of interpretation but one with sufficient influence eventually to bring into effect measures which will at least better existing conditions

The studies of the writer (he has been dealing with great numbers of generic names in the past thirty years) have shown that four-letter combinations are sufficient to throw every generic name in zoology into its family, or at least into a group of small families. They are not euphonious. The possibilities of prefix and numeral combinations may well be studied and while it may not be feasible to displace some of the lovely, descriptive generic names which have been foisted upon practically defenseless workers, there might be devised a placing system which would make possible arrangement either alphabetically or by numerical series and the placing of all biological genera in family or near family groups. This alone would mean a tremendous saving in bibliographic and taxonomic work and under such conditions we might be able to view with calmness the proposal of a new generic name with 30 or 40 or more letters.

E. PORTER FELT

BARTLETT TREE RESEARCH LABORATORIES,
STAMFORD, CONNECTICUT

WITH reference to Dr. Needham's discussion,[1] I venture to offer a few comments on particular points. He must be well aware that the Dybowski polysyllabics, one of which he quotes, have been declared invalid by the International Commission. But the Lake Baikal gammarids have valid generic names, and if Dr. Needham had seen them, as I have, he would no more want to refer them all to *Gammarus* than he would wish to return to a Linnaean or Fabrician nomenclature for the genera of dragon-flies. The five names of bumblebees, as he is also well aware, are not the names of five species, as such, but are the designations of certain mutations of subspecies of those species. The generic names quoted are names of subgenera or sections of *Bombus*, which a few authors have employed in a generic sense. This practice is not likely to become general. In the Palearctic region, the species of *Bombus* present various races or subspecies, which are designated by trinomials. These races include various mutants, for which quadrinomials are employed. The nomenclature simply follows the complexity of nature. Now here is the dilemma. If we use only binomials we are either obliged greatly to increase the number of specific names, and lose sight of the grouping of the races under aggregate species; or we must simply ignore the races in our system, as in fact Dr. Needham does in his book on dragon-flies. Similarly, if we use only trinomials, and give races and mutations equal standing in nomenclature, we again introduce confusion and obscure the facts of nature. But the system of trinomials and quadrinomials actually serves to conserve the binomial system of Linnaeus, leaving the names of the aggregate species as they were, and ready to be employed by all those who are not interested in the refinements of modern taxonomy.

There is a valid objection to the excessive multiplication of generic names, but the several cases must be considered by experts, and not decided offhand by those who have not studied the animals concerned.

There is a serious objection to excessively long generic names. Long ago it was proposed that no generic name should contain more than six syllables. I have in my own practice treated this as a rule and it ought to be made one, permitting of no exceptions.

Much trouble has resulted from the practice of "emending" names in the past, but the rules permit the correction of a name if a slip of the pen or a misprint can be declared to have occurred. In recent years, particularly, the ignorance of some authors has led to the publication of misspelled or ungrammatical names, and it should be permissible to correct these, at least if the change is made without undue delay.

But after all, the troubles due to vagaries of nomenclature are nothing compared with those due to careless and inaccurate scientific work, or even to the inevitable fallibility of human powers of perception and judgment.

T. D. A. COCKERELL

UNIVERSITY OF COLORADO

WE are interested in the discussion of scientific names by Professor Needham.[1] It is inevitable that the little crustacean, laboriously designated *Brachyuropushkydermatogammarus*, is destined to be unhonored and unsung, unless by chance it be given a convenient and satisfactory nickname. It is unfortunate to launch a species upon the scientific sea with the handicap of a "bad name" which can never be lived down or in any way altered.

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[1] SCIENCE, 71: 26, January 10, 1930.

[1] SCIENCE, 71: 26, January 10, 1930.

There is a well-known law of evolution which operates toward the extinction of gigantic and cumbersome forms: the dinosaurs are already gone, the elephants and redwoods are much reduced in distribution, the whales are doomed, and likewise, we hope, battleships! Nature acts as though she appreciated the unwarranted expense involved in producing a huge beast, the difficulty of its establishing, the extravagance of its maintenance and finally its susceptibility to a single fatal accident which results in the destruction of tons of material.

A natural selection working in taxonomy should and doubtless will eliminate the long technical names which we frequently see, because they are not only useless to most of us but they impede the work of those who are expected to profit from their existence.

EDWARD L. TROXELL

TRINITY COLLEGE,
HARTFORD, CONNECTICUT

SOIL SCIENCE

IN his note in the January 17, 1930, issue of SCIENCE relative to the term "pedology" as name for soil science, Dr. W. A. Hamor called attention to its use since 1896 as the name for another science, as recognized by lexicographers.

Webster gives this: "pedology; paedology . . . 1: Med. Pediatrics; 2. Child study." In contrast Webster gives this for geology, for example, which is recognized by lexicographers as a science: "The science which treats of the history of the earth and its life. . . ." The Encyclopaedia Britannica (fourteenth edition, 1929) gives this: "Children, diseases of. The study of this subject, known also as pediatrics, is comparatively modern."

Probably most soils scientists know that in 1862 Fallou (German) published a 488-page book on pedology. Fallou defined natural soil science or pedology as the description of the nature of soils, no matter what their relation to vegetation or industry might be.

W. W. WEIR

NEW YORK CITY

DR. HAMOR'S objection to the adoption of "pedology" as a name for soil science[1] seems to be sound and his suggestion of "humology" for that use is excellent.

As a worker in the field of soil science I enter my protest against such a monstrosity as "chthonology," in which, I think, the public would join. Scientific nomenclature is cluttered up too much with useless letters; why not apply the principles of simplified spelling? If we must have Greek, write it "thonology," even at the risk of its being interpreted "wolf science" by some Greek scholar. But *humology* seems better.

A. M. PETER

EXPERIMENT STATION,
LEXINGTON, KY.

PRESS NOTICE OF THE DES MOINES MEETING IN IOWA

MR. T. J. EDMONDS, who had charge of the local publicity for the Des Moines meeting, has prepared a statement showing the amount of space given the meeting by the press of Iowa.

In advance of the meeting there were published 1,710 articles (including 30 editorials and 36 photographs) totaling 10,998 column inches. In addition, advance notice of the meeting was given from 15 radio stations.

During the meeting there were published 7,436 articles (including 33 editorials and 88 photographs) totaling 74,781 column inches.

The press of the State of Iowa alone therefore published in connection with the meeting 9,146 articles (including 63 editorials and 124 photographs) totaling 85,779 column inches.

In the Des Moines papers the meeting was noticed by 15 eight-column headlines.

AUSTIN H. CLARK,
Director, Press Service

REPORTS

AWARDS OF THE AMERICAN SOCIETY OF PLANT PHYSIOLOGISTS

THE CHARLES REID BARNES LIFE MEMBERSHIP

AT the recent Des Moines meeting of the American Society of Plant Physiologists, the fourth and fifth awards of the Charles Reid Barnes life membership were made. The two recipients of the honor were Professor George J. Peirce and Professor Charles A. Shull. Accounts of the establishment of this honorary life membership and of the first two awards are found in previous issues of SCIENCE[1] Each year the society awards to some deserving member an honorary life membership in honor of Charles Reid Barnes, the first professor of plant physiology at the University of Chicago. The three previous awards, in the order of their occurrence, were to Burton E. Livingston, Francis E. Lloyd and Herman A. Spoehr.

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[1] SCIENCE, 71: 70.

[1] SCIENCE, 65: 175–176, 1927; 67: 264–265, 1928.

Professor Peirce took his B. S. degree at Harvard University in 1890 and his Ph.D. degree at the University of Leipzig in 1894. From 1895 to 1897 he was assistant professor of botany at Indiana University. Since 1897 he has been at Stanford University, first as assistant professor of botany, then as associate professor of plant physiology and since 1910 as professor of botany. From 1909 to 1910 he was a collaborator with the U. S. Forest Service, and from 1910 to 1911 he was a special agent of the U. S. Department of Justice in the study of the effects of smoke on vegetation.

Professor Peirce has contributed numerous scientific papers, especially in the fields of respiration, irritability, parasitism and the effects of smoke and other atmospheric impurities on vegetation. In 1903 he published his text-book of plant physiology—the first book on the subject to be published in this country. In 1925, he published "The Physiology of Plants and the Principles of Food Production." He is also one of the authors of a text-book of biology.

Professor Peirce is no less known as a teacher than as an investigator and author. He takes a very great personal interest in all his students and has the happy faculty of arousing and holding their interest in the subject being discussed. He is a man of kindly personality, of great human sympathy and of broad interests. His interests extend beyond the realm of his science, as is evidenced by his election to the chairmanship of the Palo Alto Board of Health and the Palo Alto Chapter of the Red Cross.

Professor Shull received his B. S. at the University of Chicago in 1905 and his Ph.D. degree in 1915. During part of his graduate student days he was a member of Dr. Barnes's classes and also his student assistant. He traces much of his interest in plant physiology to the inspiration received from Dr. Barnes. He was assistant professor of biology at Transylvania College from 1906 to 1908, and professor of biology and geology from 1908 to 1912. From 1912 to 1918 he was at the University of Kansas, first as assistant professor of botany and then as associate professor of plant physiology and genetics. During the period from 1918 to 1921, he was professor of plant physiology and head of the department of botany at the University of Kentucky. He went to the University of Chicago in 1921 as associate professor of plant physiology. Since 1925 he has been professor of plant physiology at this institution.

Professor Shull has exerted a great influence on plant physiology in several different ways, notably as an investigator, as a teacher and as an editor. He is the author of a large number of scientific papers which have added much to our knowledge, especially in the fields of seed germination, permeability, water relations of seeds and plants, water-holding power of soils, respiration and the energy relations of the leaf. His teaching is characterized by clarity of presentation and by contagious enthusiasm. His lectures fairly bristle with the problems remaining to be solved in plant physiology. Many a student has been led to make plant physiology his field of research through listening to his lectures. The recent successful establishment of the American Society of Plant Physiologists and its official journal, *Plant Physiology,* and the placing of these enterprises on a firm foundation were due more to the courage, clear vision and hard work of Professor Shull than to any other one person. He is editor-in-chief of *Plant Physiology* and associate editor of *Botanical Gazette.*

The members of the committee for the fourth and fifth awards of the Charles Reid Barnes life membership are J. D. Sayre, Earl S. Johnston, R. B. Dustman, J. H. Gourley and Walter Thomas, *chairman.*

THE STEPHEN HALES PRIZE

In 1927, Professor Charles A. Shull, then president of the American Society of Plant Physiologists, conceived the idea that this year, the two hundred and fiftieth anniversary of the birth of Stephen Hales, would be an opportune time for the society to do honor to this pioneer plant physiologist and biological investigator who stands as a prominent landmark in the scientific horizon of the seventeenth and eighteenth centuries. Under Professor Shull's leadership, there was established by the society the Stephen Hales prize endowment fund. Every other year a prize and certificate are to be awarded to some deserving plant physiologist of North America. The first award was made at the recent Des Moines meeting.

After long and careful consideration, the committee made the award to Professor D. R. Hoagland, professor of plant nutrition at the University of California and chemist of the California Agricultural Experiment Station. Professor Hoagland took his A. B. degree at Stanford University in 1907 and his A. M. degree at the University of Wisconsin in 1913. He was instructor in agricultural chemistry at the University of California from 1907 to 1910, chemist in the U. S. Department of Agriculture from 1910 to 1913 and assistant professor of agricultural chemistry at the University of California from 1913 to 1920. Since 1920 he has been associate professor of plant nutrition at this institution, and since 1925 he has been chemist in the California Agricultural Experiment Station.

Professor Hoagland has contributed numerous scientific papers especially in the fields of mineral nutrition of plants, soil acidity and soil and plant interrelationships. In the field of the mineral nutrition of plants he has done much to elucidate the process of the absorption of salts by the plant and to explain some of the anomalies appearing in this important plant physiological process. In studying the mineral nutrition of plants, it is of course important to control the environment. Professor Hoagland has devised an apparatus by which the conditions of light, temperature, humidity and culture solution may be controlled to such a degree that the growth of plants in duplicate experiments is identical as measured by yield, number of tillers, height of tops and other external features.

In view of the very great services of Professor Hoagland to plant physiology, the committee is very glad to make the first award of the Stephen Hales prize to him. The members of the committee are A. L. Bakke, C. R. Ball and J. B. Overton, *chairman*.

S. V. Eaton,
President
H. R. Kraybill,
Secretary-treasurer

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE COLORIMETRIC DETERMINATION OF SOIL REACTION

While electrometric methods are now generally applied in the determination of the reaction of soil suspensions, the different electrodes do not always agree in their indications, and for this and other reasons it may be desired to obtain results by a colorimetric method. In order to observe slight differences in tint of indicators, it is essential that a clear water extract of the soil be obtained. Various means to this end have been employed, such as filtration on conical or Buchner funnel with paper repeatedly extracted until the apparent reaction of pure water is not affected by contact with it, dialysis, centrifuging, etc. Some of these procedures are objectionable on account of the time required, others because it is difficult to protect the extract from contamination. It has been found that clear water extracts can be obtained from many soils without the use of any filter medium other than the soil itself, in a reasonable length of time and without great risk of contamination, by means of very simple apparatus. The method may not succeed with soils which tend to run together and lose their crumb structure when wetted, or with samples that have been ground, but in any case it is easy to determine the possibility of obtaining a clear extract in this way.

A percolating tube is made from a thin Pyrex test-tube, about 17 mm internal diameter, by drawing out the lower end to a cone about 5 cm long and 2 mm wide at the narrowest point. It is cut at this point and the thin tip heated to thicken and contract to about 1 mm inside diameter at the tip. About 25 g of the finely granular air dry or slightly moist soil is charged into this percolator, gently shaken down and about the same amount of water poured on top. With most soils the water will penetrate the soil without much difficulty, and after a few drops have run from the tip, the percolate will be clear. The clear extract is received in the test-tube which is to be used for the color comparison, marked at 10 ml with a wax pencil, and suitably supported. The conical bottom of the percolator fits into the mouth of this test-tube and excludes air. As soon as sufficient extract has been collected, the indicator is added and the color compared with buffer mixtures in similar tubes. As water extracts of most soils are practically unbuffered, it is essential for accuracy to use isohydric indicator solutions and other precautions described by Fawcett and Acree[1] in a recent paper. Several duplicate samples of soil should be percolated at the same time in order to have sufficient extract for the repeated tests which may be necessary to determine the reaction with precision.

C. J. Schollenberger

Ohio Agricultural Experiment Station,
Wooster

A METHOD FOR DETERMINING HARDINESS IN PLANTS

Methods of measuring the hardiness of plants by correlation with chemical and physical properties have been the subject of great interest and investigation in the past few years. A new method based upon the degree of exosmosis of electrolytes from tissue after freezing has been worked out in a preliminary way, and determinations of exosmosis have been made at weekly intervals throughout the autumn on alfalfa roots from varieties of known hardiness. The amount of outward diffusion into distilled water is determined by conductivity measurements, which indicate a progressive development of hardiness throughout the autumn period in the hardy varieties, while the tender varieties show no such change. At the end of November, the differences in exosmosis as measured by this method amount to several hundred per cent. between the very tender and the most hardy varieties. Colorimetric tests for chlorides and nitrates in the exudate from the frozen roots correlate very well with the conductivity measurements, and regeneration of growth in the greenhouse indicates that injury by freezing may be closely estimated by this method. The author plans to investigate its application to other plants and to perfect details of technique. The precise experimental method and results will be published soon.

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[1] Edna H. Fawcett and S. F. Acree, "The Problem of Dilution in Colorimetric H-ion Measurements. 1. Isohydric Indicator Methods for Accurate Determination of pH in Very Dilute Solutions," *Journal of Bacteriology*, vol. 17, no. 3: 163–204.

S. T. DEXTER

DEPARTMENTS OF AGRONOMY AND
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UNIVERSITY OF WISCONSIN

A SOURCE OF DIASTASE

EXPERIMENTS designed to illustrate digestion are not uncommon in beginning courses in botany, the action of diastase or amylase on starch paste being a common method of procedure. Ptyalin, contained in the saliva, may be successfully employed, but for classes involving large numbers of students this is difficult to obtain in sufficient quantity. Malt diastase may be prepared, if facilities are available, but the extraction must be performed with care, and the yield is small unless large-scale operations are employed. The ordinary commercial preparations, available on the market under various trade names, are unsuited, since they contain starch or sugar or both and thus vitiate the results before the experiments are started. After a considerable canvass of the situation, a source of diastase has been found which meets the requirements of a starch- and sugar-free enzym which is not only entirely suitable for experiments of the nature indicated, but which is useful in a number of physiological and biological procedures as well. Since it seems apparent that teachers generally are unaware of an easily obtainable enzym, this note may not be out of place.

The Digestive Ferments Company manufactures and sells a digestive ferment under the trade name of "Pangestin." The manufacturers claim that it is capable of converting eighty parts of potato starch into water soluble substances in five minutes in accordance with the U. S. P. X Revision test for pancreatin. Pangestin has good solubility, with a small amount of extraneous material not identified. Both the dry enzym and aqueous solution give a negative test for starch. Freshly made aqueous solution and the same after standing fifteen hours give a negative test for glucose. The digestive power has been tried on potato, corn and other starches in 2 per cent. aqueous paste form. Ten minutes at room temperature, and without an activator, give very positive tests for sugar with Fehling's solution. Cornstarch is apparently acted upon more rapidly than potato starch.

Pangestin is not a simple enzym. Not only is it strongly amylolytic, but, because it is of animal origin, it is also proteolytic, as shown by its power to digest completely the white of egg, and lipolytic, as shown by the hydrolysis of oils, such as cottonseed and olive. It is therefore a mixture of enzyms. This does not, however, detract from its usefulness, but rather enhances it. So far as the writer has been able to ascertain, Pangestin is the only trade product made in America conforming to the requirements of a starch- and sugar-free enzym, although several other chemical companies have signified their interest in the production of a purified product. One German product submitted has also been tested out, but has been found unsatisfactory.

CHAS. H. OTIS

UNIVERSITY OF WISCONSIN

SPECIAL ARTICLES

NITROGEN FIXATION BY BLUE-GREEN ALGAE

NITROGEN fixation, a property common to several species of bacteria and a few fungi, has long been suspected as being a property of algae also. Considerable research by several investigators with green algae (*Chlorophyceae*) has failed to demonstrate that any one of these possesses the ability to use free nitrogen gas. The few claims that have been made to the contrary have been disproved, to the satisfaction of probably all the workers in this field. The writers have recently had occasion to check this point further. Three cultures of green algae, namely, *Chlamydomonas*, *Chlorella* and *Scenedesmus*, obtained from Cornell University through the courtesy of Dr. F. B. Wann, and a *Pleurococcus*, isolated from a local soil, were repeatedly tested for nitrogen-fixing powers, with negative results.

What are the facts regarding the nitrogen-fixing ability of the other common group of algae, known as the blue-greens (*Cyanophyceae*)? Many articles have appeared during the past forty years in which references are made to the fact that under various experimental conditions, particularly in greenhouse pots, there occurred gains in nitrogen or increased growth of higher plants where abundant growths of blue-green algae were present. In these greenhouse experiments the blue-green algae were growing in association not only with higher plants in most cases but with bacteria, fungi, green algae and all the other common soil micro-organisms. Hence it was impossible to attribute the fixation directly to the blue-greens. The fact that these forms were nearly always present in abundant numbers where the unexpected nitrogen fixations occurred naturally led many workers to suspect that they were the agents responsible. Others, however, stressed the fact that Azotobacter and other free-living bacteria were nearly always found closely associated with the dense algal growths. This observation formed a basis for the other commonly accepted idea that a sort of symbiotic relationship exists between the two types of organisms. In such a symbiosis the algae by means of their chlorophyll are supposed to furnish carbohydrates for the non-symbiotic bacteria, while the latter fix nitrogen, a portion of which the algae use. During the past few years this symbiotic theory has probably been more generally accepted than that of direct fixation by algae, because no one could demonstrate that any alga could use free nitrogen. In the case of blue-greens the failure to demonstrate fixation may be attributed largely to the difficulty of securing pure cultures. In the gelatinous algal sheaths, bacteria thrive and are eliminated only with great difficulty by ordinary bacteriological methods.

A few years ago the writers began nitrogen-fixation studies with blue-green algae, isolated from a local soil. In preliminary culture work these organisms in mixture with other soil organisms were found to fix as high as 40 mg nitrogen per 100 cc of nutrient solution, containing 1 per cent. sucrose, when exposed to sunlight in the laboratory window for approximately a year. These crude cultures were partially purified by being repeatedly plated out. In order to make the final separation, the algal cultures containing bacteria were exposed to ultra-violet light from a quartz mercury vapor lamp for periods varying from one to twenty minutes. Most of the bacteria were killed by exposures longer than five minutes, but several attempts had to be made before complete sterilization resulted without appreciable injury to the algae. In January, 1929, pure cultures were finally secured by use of this method. Freedom from bacteria and other organisms was determined by inoculation onto four commonly used bacteriological media, as well as by repeated direct microscopic examinations. When grown on a nitrogen-free medium through which a stream of air, purified by passing through sulphuric acid and sterile water, was constantly bubbled, the organisms were demonstrated to possess the ability to fix atmospheric nitrogen. During a period of 75 days' incubation, an average fixation of 5 mg nitrogen was obtained per 100 cc of a culture medium originally containing no nitrogen or sugar. Where one gram of sucrose was added the fixation was 8.5 mg nitrogen. The cultures were grown at room temperature in a southwest window where they received direct sunlight for approximately three hours each day. The growth requirements for the blue-green algae used are very simple; a complete nutrient medium usually produces the best growth, but even tap water, containing .05 per cent. K_2HPO_4, with a satisfactory light source produces a rather good growth. In the absence of light, if sugar is present in the medium, the organisms live for months and retain their normal color, but the growth is very slight. In the dark, fixation was so slight as to be almost within experimental error, but growth even in the presence of combined nitrogen was also slight. Additional experiments to determine this point are in progress.

The identification of the alga used in most of the experiments has not as yet been definitely made. Professor W. R. Taylor, of the University of Pennsylvania, is giving a very generous portion of his time in helping out on this phase of the work. He reports that because of the fact that it has grown for such a long time on artificial media, it is in many respects rather abnormal. Considerable additional culture work will be necessary to identify definitely the organism but, in general, Professor Taylor states that its characteristics agree rather closely with those of *Anabaena variabilis* Kütz. Another culture corresponds in most respects to *Phormidium molle* (Kütz) Gom. These names are given here merely as provisional designations until further studies are completed. The point of immediate importance is not the exact identification of the nitrogen-fixing species but rather the fact that a pure culture of a blue-green can use free nitrogen gas.

It is not the intention of the writers to leave the impression that this is the first time that blue-green algae have been grown in pure culture or demonstrated to use free nitrogen. Pringsheim[1] in 1912 was probably the first to grow blue-green algae, *Oscillatoria* and *Nostoc* species, free of bacteria. He did not demonstrate that either could fix nitrogen. A short time after the writers had obtained *A. variabilis* Kütz in pure culture and while a series of experiments was already under way to test its ability to use free nitrogen, the recent excellent paper of K. Drewes[2] came to our attention. He grew *A. variabilis, Nostoc punctiforme* and another species of *Anabaena* in pure culture and obtained about 2 to 3 mg of nitrogen fixed per 250 cc of nitrogen-free nutrient solution during a period of two months. It is quite a coincidence that workers so far separated should have isolated what appears to be the same organism from different soils and independently demonstrated its powers of nitrogen fixation at so nearly the same time. The results agree very closely except that the quantities of nitrogen fixed were relatively larger in our results, 1.67 mg nitrogen per 100 cc per month in a sugar-free solution as contrasted with a corresponding figure of 0.6 mg nitrogen in Drewes' results. This point is not important, however, since the light intensity, quantity of CO_2 available, temperature and amount of inoculum are all important factors affecting the total fixation.

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[1] E. G. Pringsheim, "Kulturversuche mit chlorophyll-führenden Mikroorganismen. Zur Physiologie der Schizophyceen," *Beitr. Z. Biol. d. Pflanzen*, Bd. 12, 1913: 49–108.

The economic significance of these findings remains to be determined, and work is being continued in this laboratory in the hope of learning more about the factors that influence the fixation, importance in nature and mechanism of the process. The fact, now definitely proved, that a chlorophyll-containing plant growing in pure culture can fix nitrogen in quantities far greater than experimental error puts additional emphasis upon the old question as to whether higher green plants in pure culture can use free nitrogen. Undoubtedly, more nitrogen is now being fixed in nature than can be accounted for by any previously known agencies of fixation. This statement is based largely upon the large energy requirements of non-symbiotic nitrogen-fixing organisms. The blue-green algae get most of their energy from sunlight, and the nitrogen that they fix costs little. We know that many species of these organisms are found in almost all soils and in fresh water, but their importance is largely unknown. It is, at least, significant that Robbins[3] in his study of the algae of Colorado soils, where nitrogenous salts often accumulate to such an extent as to cause "niter spots," isolated twenty-one species of algae, all but two of which were blue-greens. The most prevalent organisms were *Phormidium, Nostoc, Anabaena, Nodularia* and *Stigonema*. Robbins did not, of course, know that many or perhaps all of these forms are able to fix nitrogen. He considered that they are of importance in nitrogen fixation because they furnish energy for Azotobacter.

In the light of these results it is likely that blue-green algae are important non-symbiotic nitrogen-fixing organisms. They may, indeed, be the most important nitrogen-fixing agents in many agricultural soils.

F. E. ALLISON
H. J. MORRIS

BUREAU OF CHEMISTRY AND SOILS,
U. S. DEPARTMENT OF AGRICULTURE,
OCTOBER 9, 1929

SALINE DRINKING WATER

BECAUSE of the ease of modern modes of transportation, man of to-day is exposed to an ever-increasing change in living conditions to which he must adjust himself. Without a doubt, water is the greatest variable which one encounters in passing from one region to another, and it is this variable which is responsible for the greatest physiological changes in the body.

The waters of certain areas of the United States are either quite free from dissolved salt or contain only very small amounts. Such waters are called "soft" waters. In contrast to these practically salt-free waters are those waters which have come into contact with limestone beds and have taken up calcium carbonate in the form of the bicarbonate. Such waters are said to have temporary hardness. Surface waters which have passed through alkaline soils, or well and spring waters which have come into contact with salt beds, will dissolve these salts and will consequently have a brackish taste.

Large sections of the southwestern part of the United States have alkaline soils which impregnate surface waters with salts, and in addition there are in these regions extensive salt beds which contaminate the deep wells and many of the springs. The salt content of the rivers in these sections is often so high that it will kill vegetation along their shores. The salts present in these waters are sodium chloride, calcium chloride, calcium sulphate and magnesium sulphate. Analyses of waters from such sections have shown these salts in certain instances to be present in excess of 200,000 p.p.m., and 5,000 to 50,000 p.p.m. are common.

The question of the possible deleterious effects of such waters upon the animal organism immediately presents itself. Travelers drink such salty waters with considerable hesitation on account of their unpleasant taste and disagreeable physiologic action. Live-stock growers frequently attribute the death or poor condition of their stock to the salty waters which the animals must drink. This is especially true where the cattle drink from small streams which receive waste saline waters from the oil wells.

Strange as it may seem, scientific literature does not answer this vital question. There are volumes of semi-popular articles dealing with the medicinal properties of certain spring water. In the pharmaceutical literature the physiological action of certain salts is recorded, but practically nothing can be found in regard to the physiological effects of the ingestion of saline drinking water. In a pamphlet published in 1925 by the U. S. Public Health Service, "Drinking Water Standards," an arbitrary standard is set for waters which are to be used on interstate commerce carriers, but it is a matter of common knowledge that much of the water being used continually by people in the southwest contains more saline matter than is permitted by the U. S. Health Service, and, nevertheless, there is no evidence of any deleterious effects arising as a result.

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[2] K. Drewes, "Über die Assimilation des Luftstickstoffs durch Blaualgen," *Centbl. Bakt., Par.*, etc., 2. Abt., Bd. 76 (1928): 88–101.

[3] W. W. Robbins, "Algae in Some Colorado Soils," Colorado Agr. Exp. Sta. Bull. 184 (1912): 24–36.

An investigation was begun in an attempt to answer the following questions in regard to saline waters. 1. What is the effect of the presence of considerable quantities of salt in our daily drinking water? 2. At what percentage does salt become deleterious to the organism? 3. Is it possible for the organism to adjust itself in time to saline drinking waters? The experimental animals used in this work were rats and other small animals. They were placed upon well-balanced rations supplemented with drinking water which was prepared by dissolving different amounts of various salts in distilled water. Sodium chloride was added to the water in amounts ranging from 500 p.p.m. to 50,000 p.p.m. Similar series were tried using calcium chloride, magnesium sulphate, sodium carbonate, sodium bicarbonate and calcium sulphate (up to the limits of saturation). The general appearance of the animals, their growth rate, their ability to reproduce and to rear their young and the condition of their organs at death were considered in studying the effects of the various salts upon the animal.

The first point determined was the maximum percentage of a single salt which could be administered in the water without producing harmful effects upon the animal. Mixtures of the salts were also added to the water to determine whether there might possibly be an antagonistic action between the various ions: that is, whether the deleterious effect of one ion might not be offset by the effect of a second ion. Such an antagonistic ion effect has been observed in certain body processes and also in plant nutrient solutions between sodium, calcium and magnesium ions.

From the data obtained, it is possible to postulate that 15,000 p.p.m. of magnesium sulphate has a retarding effect upon growth and that increases the mortality rate of the young. Twenty-five thousand p.p.m. of magnesium sulphate have a decided toxic effect. Calcium chloride produces even more harmful effects. No normal litters were found among rats drinking 10,000 p.p.m. of this salt; 15,000 p.p.m. lessen the growth rate, and 25,000 p.p.m. produce death. Ten thousand p.p.m. of sodium chloride affect reproduction unfavorably; 20,000 p.p.m. cause the growth of the animal to be stunted, and 25,000 p.p.m. produce a rapid decline in weight. Sodium carbonate is decidedly deleterious at a concentration of 20,000 p.p.m., and reproduction was interfered with at quite low levels. Sodium hydrogen carbonate is less injurious to the animals. A combination of 20,000 p.p.m. of sodium chloride and 5,000 p.p.m. of magnesium sulphate or calcium chloride inhibits growth. The results of feeding various other combinations of salts seem to indicate that in animals there is no antagonistic action between the ions such as there is in plants. The chlorine ion appears to be more toxic than either the carbonate or the sulphate ion. The calcium and magnesium ions are more harmful than the sodium ion. This can be explained by certain known physiological actions of ions. It is interesting to note that as the salt concentration increased the amount of water consumed by the animal daily also increased up to the point where the animal preferred to die of thirst rather than drink the necessary amount.

When animals which had been given a salty water were placed on distilled water soon after their first loss in weight, they rapidly regained their weight and appeared not to have been permanently injured by the saline content of the water. Animals which have received the salty water for some time seem better able to stand such water than do animals which are suddenly changed from distilled water to salty water.

The above results indicate that the continued use of saline solutions as drinking water produces injurious effects upon the animal organism. The concentration at which the solution becomes harmful varies with the particular salt used. The animal organism can apparently accustom itself within limits to a saline water, but in all probability it can not become adjusted to the effects of high concentrations.

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C. H. Larwood

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BOOKS RECEIVED

Chamberlin, Thomas C., and Rollin D. Salisbury. *College Text-Book of Geology.* Part II. Historical Geology. Rewritten and Revised by Rollin T. Chamberlin and Paul MacClintock. Pp. ix + 497 + xxviii. 353 figs. Holt. $3.75.

MacPherson, Hector. *Modern Cosmologies.* Pp. viii + 131. 12 illustrations. Oxford University Press. $2.75.

Sandford, K. S., and W. J. Aakell. *Paleolithic Man and The Nile-Faiyum Divide.* Pp. xv + 77. 11 plates. 25 text figures. University of Chicago Press. $5.00.

Terrill, H. M., and C. T. Ulrey. *X-Ray Technology.* Pp. viii + 256. 143 figs. Van Nostrand. $4.50.

Walther, Johannes. *Leopoldina.* Pp. xviii + 575. In German and English editions. Verlag Von Quelle & Meyer. Leipzig, Germany.

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THE MOTIONS OF THE B STARS[1]

By Dr. J. S. PLASKETT, F.R.S.

DIRECTOR OF THE DOMINION ASTROPHYSICAL OBSERVATORY, CANADA

The radial motions of the B type stars have been discussed by Frost and Adams, Campbell, Kapteyn, von Pahlen and Freundlich and by many others. Frost and Adams, from the radial velocities of twenty B type stars, were the first to direct attention to and Campbell, from much greater observational material, to confirm the results of these early observations, that the peculiar radial velocities, the velocities remaining after the component of the solar motion was removed or the actual velocities with respect to the stellar system, were much smaller for the B stars than any other spectral class, and further, that there was a large excess of velocities of recession, positive velocities, on the average nearly 5 km per sec., as if the system of B stars was expanding with respect to the sun.

This K term, as Campbell called it, which in his final determination had a value of +4.9 km per sec. and which was practically non-existent in other spectral types than B, caused considerable speculation. Attempts to explain it as due to a personal equation in the measurement of the broad-lined B type spectra, to errors in wave-length or to a red displacement of the effective center of absorption produced by some physical cause could not be made to account for more than a small part of the 5 km observed. The Einstein redward shift of the spectral lines of massive stars was later brought forward as a cause of this mysterious effect but on no probable assumption of mass and density could the displacement thus produced exceed a fraction of a kilometer.

A new departure in the explanation of this mysterious K term appeared a few months ago in the *Potsdam Publications* in a paper by von Pahlen and Freundlich who claim that it represents a real motion of the B stars and is produced by an orbital motion of the stars around a very massive center, the center of the stellar system. On their hypothesis these orbits are very eccentric, $e = 0.9$ or so, and the sun and the cluster of B stars have just passed the apogalactic point, the point most distant from the center. As the orbital velocity will increase as the stars approach the center of the galaxy, the B stars preceding the sun will be moving faster and those following slower than the sun, thus giving an apparent expansion, a K term. They were thus able to explain not only the distribution of the then known residual velocities of the B stars but also other systematic motions of the stars in general, but this could be done only by rather special and somewhat artificial assumptions.

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[1] Address of the retiring vice-president for Section D—Astronomy, American Association for the Advancement of Science, Des Moines, Iowa, December 31, 1929.

Objections may be urged to several of the hypotheses and methods used by von Pahlen and Freundlich, but this is scarcely necessary as the introduction of additional material, the radial velocities of about 450 fainter B stars obtained at the Victoria Observatory, so changes the nature of the observational data on which their investigation was based as to require a complete revision of the theory. As will be seen later, the motions of the B stars are well and simply explained by a general rotation of the stellar system around a massive and distant center, the orbits of the individual stars being nearly circular instead of highly eccentric as in von Pahlen and Freundlich's investigation.

The material for the present discussion of the motions of the B0 to B5 stars, to which it has been limited, as the classes B8 and B9 are generally taken as belonging to A type stars, has been gradually accumulating at Victoria since 1924 in the determination of the radial velocities of all B0 to B5 stars brighter than 7.5 visual magnitude and north of −11° declination, by Mr. J. A. Pearce and the writer. There were about 450 stars in this program, which with those previously determined gave the radial velocities of 815 B0 to B5 stars, nearly 500 more than were available to Campbell or von Pahlen and Freundlich. These 815 radial velocities or rather the 815 residual velocities, the velocities after removal of the component of the solar motion, the velocities with respect to the stellar system, were analyzed with particular reference to the theory of a rotation of the galactic system as introduced by Lindblad and further developed by Oort and the writer.

This theory assumes that the great galactic system is in practically circular rotation around a very distant and massive center supposed to coincide with the center of the globular cluster system at galactic longitude 325°. If, as seems likely from analogy with the spiral nebula, there is a condensation of the matter or stars towards the center, the law of force will approach that of the inverse square, the stars nearer the center will revolve more quickly than those farther out, somewhat similar to the solar system where the inner planets move much more quickly than the outer. In such a case, it is obvious there would be a relative motion of the stars nearer to or farther from the center with respect to the sun, or a rotation of the galaxy could be measured.

Oort analyzed the consequences of such a rotation and showed that the residual velocities were proportional to the distance from the sun and varied with the sine of twice the angle between the star and the direction to the center. Expressed mathematically, all positions being referred to galactic coordinates:

$\bar{\rho} = K + \bar{r}A \sin 2(\bar{l} - l_0) \cos^2 \bar{b}$, where

$\bar{\rho}$ = Mean residual velocity, the velocity with solar motion removed

$\bar{l}$ = Mean galactic longitude

$\bar{b}$ = Mean galactic latitude. All these barred terms refer to the average of a small group of stars, this grouping being necessary on account of the peculiar or random motions of individual stars.

K = Mean residual velocity with regard to sign

$\bar{r}$ = Average distance of the whole group of stars

A = Rotational term, about 1 km per sec. for stars about 60 parsecs, 200 light years away

l_0 = Direction to the center of rotation, generally taken as galactic longitude 325°, the direction of the center of the system of globular clusters.

Using this relation and the method of least squares, Oort showed that the motions of the more distant stars were very similar to those that would be produced by such a rotation of the galaxy. This was further confirmed by an analysis of the motions of part of the B stars discussed in the present paper which was presented by the writer to the Royal Astronomical Society two years ago. The galactic rotation is still more strongly confirmed by the investigations of the radial motions of the 815 B0 to B5 stars used in this paper, and is specially marked in the most distant stars of the list where, as will be seen later, the K term disappears and the motions follow almost exactly the double wave swing produced by a galactic rotation. In a paper shortly to appear in *Monthly Notices*, the velocities of the most distant stars, and particularly the velocities of the intervening diffuse matter in the stellar system, as determined from the "interstellar" H and K lines in the spectra of these stars, show this rotational effect so distinctly and certainly as to leave no doubt of its objective reality.

The presence of this systematic effect in the radial motions of the B type stars makes it necessary, before we can speak intelligently about a residual velocity, a K term, to remove this double wave rotational term from the radial velocities in addition to the usual single wave solar motion which was the only one known and allowed for by Campbell. It is only when all known systematic motions of the stars are removed from the radial velocities that the true residual velocity, the real K term, can be obtained, and that any explanation of this mysterious effect can be final. Consequently, in order to find the real K term for the B type stars, the 815 observed radial velocities may be either analyzed simultaneously for the solar motion, the galactic rotation and the K term or preferably, as the stars are unsuitably distributed for the accurate determination of the solar motion, the component of the usual solar motion may first be removed and then the remaining 815 residual velocities analyzed for the galactic rotation and the K term.

It seems evident, however, before proceeding with the solution, as the rotational term is directly proportional to the distance from the sun and varies with the direction or longitude, that it will be necessary to divide the stars into groups at different distances and then further subdivide into smaller groups in galactic longitude. It has long been known that the B0 to B2 stars are considerably more luminous and hence more distant than the B3 and B5 stars, thus making two main distance divisions, containing 185 B0 to B2 and 630 B3 to B5 stars respectively, which should be separately considered. Each of these divisions was arranged in three groups according to apparent magnitude and hence, assuming small dispersion in absolute magnitude, according to distance. The first group contains all stars, 390 in number, brighter than 5.5 visual magnitude, and includes practically all those available to earlier investigators. The second contains 196 stars between 5.5 and 6.5 and the third 229 stars between 6.5 and 7.5 or fainter magnitudes. Each of these six groups was subdivided into a number of subgroups, in longitude, varying from 7 to 18, as shown in Tables I, II and III, and the mean longitude and mean residual velocity were obtained for each subdivision. It is desirable to use small groups rather than individual stars in the solutions, as thereby some of the irregularities caused by the peculiar or random motions of the stars are avoided.

These six separate main groups were solved by the least squares, using the equation given above, with l_0 taken as 325°, and yielded the following values of $\bar{r}A$ and K.

TABLE I

SOLUTIONS FOR $\bar{r}A$ AND K

Mag. Intervals	Types	No. Stars	Mean Mag.	No. Long. Div.	$\bar{r}A$	K
0 to 5.5	BO to B2	93	3.95	13	+ 2.1 ± 1.6	+ 5.8 ± 1.0
	B3, B5	297	4.65	18	− 0.4 ± 0.9	+ 4.8 ± 0.6
5.5 to 6.5	BO to B2	39	6.04	7	+ 16.3 ± 1.8	+ 0.2 ± 1.2
	B3, B5	157	6.07	10	+ 2.8 ± 1.2	+ 1.4 ± 0.8
6.5 to 7.5	BO to B2	53	7.15	9	+ 13.2 ± 2.0	− 0.5 ± 1.4
	B3, B5	176	7.01	10	+ 3.6 ± 0.8	− 0.5 ± 0.6

The first five columns of Table I are self-explanatory and show graphically how the 815 stars are arranged into distance and longitude groups. The sixth column containing the values of the rotational term from the six main groups may preferably be first discussed. The $\bar{r}A$ for the two groups of brighter stars is small and practically indeterminate, owing partly to the brightness and hence the relative nearness of the stars but mainly, as will be seen later, to irregular systematic motions of certain groups of these stars. For the fainter stars, especially those of types B0 to B2, the rotational term is well defined, from 7 to 9 times the probable error, and corresponds, by the relation given previously of 1 km per sec. for stars 200 light years away, to average distances of the groups of about 3,000 light years, although for the B3, B5 stars fainter than 5.5 magnitude, the average distance is less than 1,000 light years. The smaller value of the rotational term for the faintest group of B0 to B2 stars may be ascribed partly to possible large random motions of single stars in the small groups but mainly to large dispersion in absolute magnitude so that apparent magnitudes do not necessarily represent relative distances.

That all these fainter stars show distinctly and certainly the presence of the rotational effect is at once evident when the mean observed residual velocities of the various longitude groups are compared, as in Table II, with the velocities computed from those values of $\bar{r}A$ and K obtained in the solutions and given in Table I, and below the columns in Table II. It is scarcely conceivable, especially when the possible disturbing effects of large peculiar or

TABLE II

COMPARISON OF OBSERVED AND COMPUTED VELOCITIES

B0 to B2 Stars

5.5 to 6.5 Mag.				6.5 to 7.5 Mag.			
No.	$\bar{l}$	$\bar{\rho}$(Obs.)	$\bar{\rho}'$(Comp.)	No.	$\bar{l}$	$\bar{\rho}$(Obs.)	$\bar{\rho}'$(Comp.)
1	338°	+ 7.3	+ 7.1	1	359°	+ 36.3	+ 11.7
6	32	+ 15.2	+ 11.7	6	40	+ 11.7	+ 6.2
5	48	+ 9.1	+ 3.9	6	50	+ 2.1	+ 1.9
7	77	− 12.8	− 10.0	9	69	− 5.6	− 6.6
3	134	+ 1.2	− 2.5	4	91	− 19.8	− 12.8
6	160	+ 6.6	+ 8.2	8	109	− 12.3	− 12.8
11	180	+ 12.6	+ 15.2	6	148	+ 5.5	+ 0.9
				6	168	+ 2.6	+ 8.7
				7	179	+ 6.3	+ 11.4
	$\bar{r}A = +16.3$; $K = +0.2$				$\bar{r}A = +13.2$; $K = -0.5$		
			B3, B5 Stars				
15	359	+ 5.4	+ 4.0	7	55	+ 5.9	+ 3.0
24	29	+ 0.9	+ 3.6	27	22	+ 3.5	+ 2.8
25	56	− 1.8	+ 1.4	20	37	+ 2.4	+ 1.6
15	76	− 3.5	− 0.4	18	56	+ 1.9	− 0.6
16	120	+ 1.0	− 0.7	26	76	− 4.0	− 3.0
23	164	+ 6.2	+ 3.2	19	93	− 5.7	− 4.1
21	177	+ 3.1	+ 3.9	16	126	+ 0.6	− 2.8
11	208	+ 3.8	+ 3.7	13	148	− 0.8	− 0.2
5	245	+ 11.9	+ 0.5	20	167	− 2.2	+ 2.0
2	307	+ 5.1	− 0.2	10	182	+ 2.8	+ 3.0
	$\bar{r}A = +2.8$; $K = +1.4$				$\bar{r}A = +3.6$; $K = -0.5$		

random velocities on the mean residual velocities of groups with few stars is considered, that such a close agreement between observed and computed velocities can be accidental. If the double wave swing of the observed velocities from positive to negative and back again to positive is not produced by a galactic rotation it must be due to some cause which gives a systematic trend of the velocities almost exactly similar to a galactic rotation.

It is evident, therefore, that these rotational effects should be removed from the observed radial velocities in addition to the solar motion. Obviously this has been done in the solutions, and the remaining residual velocity, the true K term, is shown in the last column of Table I. Its value for the 93 B0 to B2 stars brighter than 5.5 magnitude is + 5.8 km and for the corresponding 297 B3, B5 stars is + 4.8 km per sec. It is therefore little different from Campbell's value of + 4.9 km per sec., obtained from practically the same stars. It has, however, completely vanished, at least well within the probable errors of the determinations, for the stars fainter than 5.5 magnitude. That *is to say, while the application of the galactic rotation* to the residual velocities of the B stars has completely eliminated the mysterious K term from the 425 B stars fainter than 5.5 magnitude, this K term of about 5 km per sec. still persists for the 390 B stars brighter than 5.5 magnitude.

It is obvious that all the early explanations of this K term as caused by errors of measurement, errors of wave-length, displacements due to physical causes or to the Einstein shift, or the later explanation provided by the hypothesis of von Pahlen and Freundlich must fall to the ground, as it is inconceivable that these causes should not operate in exactly the same way and to the same degree for faint as for bright stars. To imagine any physical property of this uniform class of B stars which depends only on the apparent brightness or, in other words, on the distance from the sun, an insignificant member of the stellar system only about one thousandth as luminous as the B stars, is to carry anthropocentric prejudices to an absurd degree.

The explanation of the K term, therefore, must be sought in some peculiar or systematic motion of these brighter B stars, or of certain groups of these stars. It is well known that the B stars show marked clustering into groups in position and it is not unreasonable to suppose there might also be some systematic trend in the motions of these same groups. In the subdivision of the stars brighter than 5.5 magnitude into longitude groups, advantage was taken of natural separations so that these subgroups may be assumed to correspond approximately to the natural clustering of the B stars. Some information in regard to such group motions may therefore be obtained by a comparison of the observed residual velocity $\bar{\rho}$, with the computed, ρ', of the two groups of stars brighter than 5.5 magnitude, which is given in Table III. This comparison shows first of all no indication of the agreement so conspicuous in the fainter stars. This is partly due to the relative nearness of the stars to the sun thus making the rotational term small and indeterminate, but mainly to group or cluster motions of recession of some of the southern stars.

TABLE III

Comparison of Observed and Computed Velocities
Stars brighter than 5.5 Mag.

B0 to B2 Stars					B3, B5 Stars				
No.	$\bar{l}$	$\bar{\rho}$	ρ'	ρ''	No.	$\bar{l}$	$\bar{\rho}$	ρ'	ρ''
3	33°	+ 18.3	+ 7.0	+ 6.3	9	355°	+ 1.6	+ 4.5	+ 4.3
5	64	+ 3.3	+ 5.2	+ 1.6	7	12	0.0	+ 4.5	+ 4.4
7	87	+ 1.8	+ 4.1	– 1.9	19	32	+ 2.4	+ 4.6	+ 3.8
6	133	– 0.3	+ 5.0	+ 0.7	15	49	+ 2.0	+ 4.8	+ 2.5
7	162	+ 2.5	+ 6.9	+ 6.2	11	68	– 1.6	+ 5.0	+ 0.8
14	177	+ 6.7	+ 7.6	+ 8.2	11	93	– 0.3	+ 5.2	– 0.6
8	203	+ 11.2	+ 7.0	+ 7.8	16	117	– 1.1	+ 5.2	– 0.4
10	230	+ 9.3	+ 6.2	+ 4.1	15	136	+ 0.7	+ 4.9	+ 1.2
5	268	+ 12.3	+ 3.9	– 2.3	18	156	+ 7.2	+ 4.7	+ 2.9
10	291	+ 7.6	+ 4.0	– 2.0	20	175	+ 4.1	+ 4.5	+ 4.4
4	309	– 9.0	+ 4.7	– 0.2	12	195	+ 8.5	+ 4.5	+ 4.6
11	320	+ 5.6	+ 5.4	+ 3.0	22	212	+ 7.6	+ 4.6	+ 4.0
13	344	+ 1.3	+ 7.0	+ 6.3	21	230	+ 5.3	+ 4.5	+ 2.5
					24	249	+ 6.3	+ 5.0	+ 0.7
					25	271	+ 10.2	+ 5.2	– 0.8
					24	293	+ 7.8	+ 5.2	– 0.5
					19	315	+ 7.8	+ 5.0	+ 1.1
					9	329	+ 5.0	+ 4.8	+ 2.3

$\bar{r}A = +2.1$; $K = +5.8$

$\bar{r}A = -0.4$; $K = +4.8$

The great preponderance of relatively large positive observed velocities beyond longitude 200°, in the southern sky, provides an obvious reason not only for the low values of $\bar{r}A$ but for the high values of K. It can be safely assumed from the agreement between observed and computed velocities for the fainter stars in Table II that there are positive rotational terms for these two groups of brighter stars also, which are masked by the distribution of the velocities. It may be assumed from the relative brightness and distance as compared with the fainter stars, that $\bar{r}A$ for the bright B0 to B2 stars should be about + 6 km and for the B3, B5 about + 3 km. Further assuming the K term as half the computed values or + 3 and + 2 km respectively and again computing velocities we get the columns ρ''. Although without objective reality, they are still useful in indicating a possible representation of the velocities and showing that the groups mainly responsible for the high K term are those between 240° and 290° longitude.

Thus the low and uncertain values of the rotational term and the high values of the K term for these brighter stars are probably due to the high systematic recessional velocities, probably group or cluster motions, of limited groups of the southern stars, mainly between galactic longitudes 240° and 290°. This is made more probable by the relative brightness and nearness of these stars, the B0 to B2 stars in the above longitude limits being more than a magnitude brighter than the average, with a similar though smaller difference for the B3, B5 stars.

There can be no reasonable doubt, therefore, that the mysterious K term, this positive residual velocity of 5 km per second found by Campbell for the B0 to B5 stars brighter than 5.5 visual magnitude, is due mainly to the high velocity of recession of limited groups of the brightest B stars in the sky in galactic longitudes 240° to 290° in the Vela-Lupus region.

That this high excess positive velocity appears only in these particular southern groups and is absent in the northern groups of the brightest and nearest stars, and is also completely absent in all B stars fainter than 5.5 visual magnitude, shows conclusively that the mysterious K term has no particular relation to the B type stars, is not due to any physical displacement of the spectral lines or to erroneous wave-lengths and does not require the elaborate explanation of von Pahlen and Freundlich, but is probably caused entirely by an unsymmetrical distribution of the residual velocities, by a preponderance of high recessional group velocities in the Vela-Lupus region.

The average peculiar motion of the B stars, the mean residual velocity without regard to sign, after the removal of the effects due to solar motion and galactic rotation, is found to be somewhat greater than that obtained by Campbell, and varies between 9 km per second for the bright B stars to about 12 km for those fainter than the seventh magnitude. It is still considerably less than the average peculiar velocity of stars of other spectral-types, and the stars of the spectral class B0–B5 may be considered as relatively slow-moving stars, as having smaller peculiar or random velocities than any other spectral class.

In conclusion, this investigation of the motions of the B0 to B5 stars has shown that their general residual velocities, the velocities with respect to the stellar system, agree very closely with those that would be produced by a rotation of the galactic system around a very distant and massive center, thus increasing the probability of such a rotation. It has further shown that the excess positive residual of about 5 km per second found by Campbell and others has entirely disappeared, when the effects of the galactic rotation have been removed, for all the B0 to B5 stars fainter than 5.5 magnitude. Although the K term still remains for the stars brighter than 5.5 visual magnitude an analysis of the residual velocities shows conclusively that this final residual of 5 kms is mainly due to the high positive group or cluster motions of the brightest and nearest B type stars in the sky in the Vela-Lupus region and is no general characteristic of the B type stars as a class. Finally, the investigation has shown that the average residual random or peculiar motions of the B0 to B5 stars varies from about 9 km for the brighter to 12 km per sec. for the fainter stars. While considerably higher than values previously deduced, the peculiar velocities of the Bs are still less than those of any other spectral class.

It gives me pleasure to acknowledge the effective collaboration of Mr. J. A. Pearce with the writer in the observation and measurement of the spectrograms and in the calculation of the results.

ORGANIC EVOLUTION[1]

ITS PROBLEMS AND PERPLEXITIES

By Dr. ALEŠ HRDLIČKA

After cosmogony, the greatest phenomenon in nature is organic evolution.

There is no need any more of attempting to substantiate this great process. Natural history teems with its evidence. And this evidence is so convincing that some scores of thousands of men of science, who represent the most critical minds of the present human society, are without exception deeply convinced of its reality.

This does not mean, however, that this most comprehensive and complex subject is as yet well known in all its details, or understood. What the workers in natural sciences are deeply conscious of is the substantiality of this all-pervading phenomenon. They further feel that gradually they are learning its accomplishments, and some of its principles. But they are also deeply aware that they are still far from knowing all its details or processes and especially far from comprehending its essential causes and significance.

Let us survey briefly some at least of the dark areas of the field and some of its perplexities.

We may as well begin by trying to define evolution —and we are at once in serious difficulties.

There have been many attempts at such a definition; they have all failed. How even now they fail may be appreciated from two of the latest attempts.

For H. S. Jennings (1928), "The doctrine of organic evolution is the doctrine that animals and plants are slowly transforming, producing new kinds"; while for David Starr Jordan (1928), evolution is merely "the universal process of orderly change." How inadequate are these expressions, how partial; yet it seems impossible for the present to do much better.

The fact is that the totality of the great subject is not yet graspable. Every worker sees it mainly from his angle, while the phenomenon as a whole is as comprehensive as that of life itself—the two may even be synonymous, or one the discharge of the other.

An approach towards the understanding of organic evolution lies necessarily in ever-progressing, intensive research and study; research and study of its manifestations through time, of its processes to-day; and on the basis of these of its laws and principles.

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[1] Address of the retiring president of the Washington Academy of Sciences, Washington, January 14, 1930.

As matters stand now, what seem to be the more obvious of such laws or principles?

The first such apparent law seems to tell us that every organic unit has and can be derived only from a closely related previous unit. This is the principle of related parentage. It is a much more important principle than may at first be appreciated. It implies that there are no new without previous closely related forms. There are mutations but no free saltations, no unconnected origins. This law, if it proves fully to be such, implies the principle of organic continuity, of the continuity of the organic with the suborganic world, and of the continuity of this with the inorganic. And it implies the great principle of heredity or transmission of the bulk of parental characters.

The next fundamentality is that every organic unit differs congenitally more or less from every other unit, and that such differences tend to be transmitted to the progeny. These are the important laws or principles of variation, and of inheritance of new characters.

The inborn variations of characters—physical, physiological or mental—differ in their value to their bearer. Under given environmental or individual conditions some may be favorable, some effectless and some unfavorable to the organism. In the long run, the units or groups with favorable variations will tend to prevail—which is Darwin's famous, and now as true as ever, principle or law of natural selection.

Every organic unit is plastic or impressionable, and reactive or accommodable. Use and disuse of parts or the whole, and environmental agencies, cause alterations that, if the causes persist long enough, will pass from temporary to habitual, and eventually to permanent changes that will be inheritable. The principles here involved are adaptation and the fixing of adaptations. The latter is the main and undoubtedly correct principle of Lamarckism and neo-Lamarckism. It is not opposed to but cooperative with natural selection and other factors of evolution. It should more properly be known, however, as the fixing of adaptations, rather than by the old term of "inheritance of acquired characters."

And a progression or differentiation of a filial group, with the additional aid of the important factors of sex, hybridization, isolation, etc., until every member of it can be distinguished from those of the parental group, and until a return to the parental group becomes impossible (A. H.), constitutes speciation or particular evolution.

So far, all is relatively easy sailing, and in well-traveled waters. The processes involved are, in the main, fairly understandable. There is thus some grasp of what may be designated especial, individualized or particular evolution.

But when we contemplate the organic world as a whole and from its beginnings, we are confronted with a far greater phenomenon, which is a general progressive evolution.

Here is something immeasurably more difficult to comprehend. It is no less than the sequential formation, the systematic building up, of the entire organic kingdom. And its causes and meaning are elusive.

What is that something that has led to the development of organic forms from the inorganic, and that within the organic realm has led unceasingly to progress in diversity, complexity, sensibility, effectiveness, until there was reached the culmination in a genus of creatures that are self-conscious, rationally directive, relentlessly striving for more knowledge, power, for co-creation even—the creatures we know as the humans?

This general progressive evolution may really be likened to a double-stemmed vast tree, rooted in the suborganic matter and the inorganic earth. One of these stems represents the vegetal, the other, statelier, the animal kingdom. As this latter stem, which concerns us more especially, grew upward, innumerable branches of it withered and were shed off, but the main stem never ceased rising and branching anew, until it reached the present highly differentiated crown and its human summit.

Here is before us an all-pervading something in living nature to which to apply the terms of accidental or incidental would be utterly trivial and absurd. Yet if not such then what? Then it must have been inevitable, and somehow predetermined in the organization of things. General organic evolution can only be, it seems, nature's function, resultant from nature's own potentialities, organization and evolution.

But we know very little as yet about these basic potentialities, organization and evolution.

General organic evolution, we feel strongly, is as natural a process as is the particular evolution of individual varieties and species. There is no indication within the process of anything except the natural. But "nature" (which may perhaps be crudely and somewhat metaphorically defined as the earth with all it stands for fertilized by the sun and the rest of the universe), in the light of organic evolution, assumes far greater riches and importance than it has hitherto been credited with.

We may now proceed to some of the more detailed problems and perplexities of the subject.

We may as well begin with the term "evolution." Is this a correct or the best term for the great process under consideration?

(1) The word "evolution," it is well known, means merely unraveling, unfolding. This would imply that all the potentialities, all the eventual results, of organic evolution lay already fixed in the most ancestral

units of the living kingdoms, in the earliest cells, and even in their predecessors.

General organic evolution under such conditions would be merely general ontogeny. If these concepts are followed far enough they lead to the absurd. The incongruity of the term "evolution" has been felt by many workers. There are those who prefer the term "transformism," which falls short. Morgan has coined "emergent evolution," which does not improve matters. Osborn suggests "creative evolution," which obscures rather than clears. There is but one term that would appear adequate to the speaker. In harmony with "cosmogony," general organic evolution, the greatest of organic phenomena, deserves the term of "biogeny."

(2) Did organic evolution begin with a cell? We used to believe it. Many who perhaps have not had the chance to go more intensively into the subject believe it still. But those who know the cell can not believe that the cell is the beginning of organic life. The cell is already a great accomplishment in organic evolution. It is a little cosmos of its own. It is extremely complex and full of highly differentiated activities. It is a carrier of all sorts of ancestral things. It would seem that a long road in biogeny had already been covered when there was reached the first full-fledged cell.

To-day it is known, moreover, that there are whole classes of ultra-microscopic existences which seem to behave like living beings and produce definite lines of results. There are a number of them already known, as shown recently by Flexner, in pathology, and there are probably many others in nature, non-pathological and perhaps, as in the case with many micro-organisms, even helpful. Shall these ultramicroscopic somethings be called cells? They seem too minute to deserve such appellation, too minute to possess the regular cell characters. If they are organic units, they are units of a lower order than that of the cells proper. They disclose what may be designated as a suborganic kingdom. These suborganic existences must be derived from something still simpler which, it would seem, could only be peculiar aggregates of organic molecules. And such aggregates of molecules would constitute the last link between the organic and the inorganic world. Much of this is still hypothetical, but progressing studies on the colloids, ferments, enzymes, viruses and other substances are yielding many suggestions.

(3) Has origin of organic life taken place but once, or has the earth indefinite capacities in this direction?

Are there possibilities of the arising of new classes of organisms and perhaps of new lines of evolution?

It would be wrong to deny either of these propositions.

It is impossible to deny a continuous potency of nature to produce from the inorganic the suborganic, and from this the organic. But it is impossible as yet to show this, to prove it.

Sometimes we are confronted with the statement that there can not be any new "creation" for nothing of that sort has ever been witnessed. To this may be replied that a new suborganic or inorganic object would have, under present conditions, practically no chance of surviving. The world throughout is filled with forms that are eager for food. What chance of survival under such conditions would have a new limited generation of beings? That there is a possibility of such a development can not be denied. There may even be felt some apprehension. There might arise new scourges. Perhaps some of the scourges of the past could be explained thus. But even if this happened at this moment, a recognition of the new form as such would be exceedingly difficult.

It is quite probable that the biogenic powers of nature are still potent enough to produce new primordial forms that, if conditions were favorable, could in time develop into recognizable new phyla, but they could prevail only if sufficiently numerous and destructive to overcome already existing interfering forms.

As to whether any new major lines of organic beings may still develop, it seems impossible either to deny or assert. These processes are very gradual and observations of them are very difficult; and belief or disbelief alone count but little.

(4) Does evolution proceed in all organisms, and does it proceed with anything like a definite rate as to time?

All organisms are known to be impressionable. There is no organism that can not be affected by new stimuli or by changes of the old influence that acted upon it. So long as these conditions exist, so long will there be a capacity of further development, a capacity of evolution. It all depends upon the stimuli as to whether an organism will or will not evolve any further.

As to the rate at which organisms evolve, that, it is definitely known, differs greatly. There are organisms such as the medusae, ants, many other insects, some mollusks and still others that are known to have changed but little since the Cambrian, the Devonian or the earlier Tertiary times. On the other hand there are forms, of which man is one of the best examples, that have changed rapidly even since the last ice invasion. The rate of evolution therefore differs widely. There seems some possibility of an explanation of these differences. When an organism, even man himself, gets fully or nearly fully adapted to its environment, then, until something new happens, some new factors come into play, that organism will simply keep on, like a light that keeps burning evenly. But turn on a greater supply of oxygen or furnish some other suitable stimulus, and the light will flare up with renewed life and activity. The rate of evolution in any given organic line is commensurate with the influences that act upon such line.

(5) Does evolution ever reverse itself?

Here is a problem which does not seem to be difficult to answer. There is no case known in which a fully developed species has reverted to an ancestral species. But single parts, and even whole variants, can and do revert. And a progress in efficiency may be accompanied by simplification of structure. Something of this nature seems, for example, to have happened in the diatoms.

The differentiation in given phyla or organisms is led by what may be termed the chief object of such organisms. The structural parts accommodate themselves to this chief requirement. The accommodation may be partly by growth, partly by simplification. And simplification is effected by degeneration of useless or interfering parts and their eventual elimination. Man is full of examples of all this. The living system does not favor anything that has ceased to be useful, whether it is an indolent human brain or an effete appendix; it weakens, reduces and eventually eliminates in one way or another.

(6) What are the relative rôles of mutation, or sudden jumps in evolution, and of gradual changes?

When de Vries discovered mutations in his Oenotherae, it seemed as if a new principle had been discovered in organic developments. To-day, when looked at more soberly, it is perceived that mutations and the more gradual changes are merely differing steps, differing rates, of the same process, except where mutations may be accidental, as they are time and again due to poisons, rays and mechanical causes.

Mutations, as seen to-day, are not as desirable as more gradual changes. They demand much greater accommodation of the organism to them, which may not always be "healthy" or even possible. A mutation may be of such a nature as to demand a substantial change of the organism. Accommodations to lesser changes are always easier. But mutations are not changes of a distinct order.

(7) In observing general organic evolution, do we perceive in the species, genera, families, orders, kingdoms anything like life cycles?

The life cycle, in its essentials, is a universal attribute of polycellular, if not all, organisms. It is something very fundamental and general. Is it limited to individuals—or does it extend also to the species and higher groups?

Some observers are inclined to see such group life cycles (*e.g.*, in mollusks), and to explain it as in the individual by a progressively diminishing capacity of oxidation.

It is impossible to say as yet anything definite on this point. There are slowly growing indications to the effect that there are in nature factors that act simultaneously on whole groups, whole varieties, whole species, and that such groups behave in unison, as sorts of superindividuals. But all this, as so much of what preceded, is still full of uncertainties and can be decided only by future investigations. We sense that there is something in this direction but can not yet be sure.

(8) The last problem I am able to approach in the time available is one that is essentially human. How far can man hope eventually to control biogeny—biogeny of plants and animals, biogeny of his own genus?

The promise is warm, if not yet glowing. We are gradually learning the ways of nature, and how to use its powers. There is a steady advance also in understanding as to what is and what is not desirable. Nature's chemical and physical laboratories, as well as our own, are ever more effectively at our disposal. Genetics and experimental science are already trying their hands in the biogenic fields, with as yet not large but growing results. When man shall have reached so far in knowledge as clearly to distinguish the right ways, the means to proceed along these will soon follow. With the advance in the scientific knowledge of nature there can be set no limit to man's possibilities. He may confidently be expected to become an enlightened coworker with nature. But this will not be greatly achieved in our nor yet the next generation.

OBITUARY

MEMORIAL TO PROFESSOR EDWARD S. MORSE[1]

FROM a Japanese friend I have notice of an event which may be of interest to the readers of SCIENCE who knew the late Professor Edward S. Morse. The following is in part adapted from the account which appeared in the *Japan Advertiser* early in November.

On the afternoon of Sunday, the third of last November, some two hundred scientists and scholars assembled at the shell-mound near the station at Omori for the ceremony of unveiling a monument in

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[1] We learn with regret that the author of this contribution died suddenly on January 28.

honor of Morse, and in commemoration of the fact that the mound was the cradle of archeological and anthropological studies in Japan.

It will be remembered that Morse went to Japan for the first time in 1877. As he passed Omori on his first journey to Tokyo from Yokohama where he had landed, he recognized a shell-mound such as he had often investigated along the coast of Maine and elsewhere. He found that the significance of such heaps of shells was quite unknown to the Japanese, and that nothing of the kind in Japan had been noted by any foreign observer. With characteristic enthusiasm, he began investigating the Omori mound, and speedily identified it as a prehistoric kitchen midden. This investigation was the first of its kind in Japan; Morse's publication of it was the first of a series of archeological studies issued from the Imperial University, and the collection of implements and pottery from the Omori mound, arranged by Morse, was the beginning of the archeological collections in the Imperial University and in the Imperial Museum in Tokyo.

The monument which commemorates all this is in the form of a great stone slab, eight feet by five, upright upon one of its long sides, and inscribed "Omori Shell-Mound" in Chinese characters large enough to be read from the passing trains. In the middle of the upper long side is a granite jar shaped like the typical vessels found in the mound. It stands on a plinth above an inscription in honor of Morse and his contribution to science in Japan.

The memorial inscription was composed by Dr. Chiyomatsu Ishikawa, professor emeritus at Tokyo Imperial University, who was Morse's interpreter in the early days and one of his students. Associated with him in planning for the monument were two other students under Morse—Professor Chujiro Sasaki, of the Tokyo Imperial University, and Professor Tomotaro Iwakawa, of the Tokyo Higher Normal School—and a number of his friends of later years. The cost of the monument was borne by Mr. Hikoichi Motoyama, and it was designed by Prince Oyama, Dr. Arisaka and Mr. Sugiyama.

It may also interest the readers of SCIENCE who esteemed Morse to know that at the Museum of Fine Arts in Boston, where for the last thirty-three years of his life he was keeper of the Morse Collection of Japanese Pottery, the Edward S. Morse Memorial Fund was established in 1927–28 through the generosity of a large number of his friends. The income of that fund is used to augment the collections of pottery in the custody of the department of which Morse was a member, and the purchases made from it are distinguished as belonging to the Edward S. Morse Memorial Collection.

F. S. KERSHAW,
Keeper of Chinese Ceramics

RECENT DEATHS

DR. WILLIAM H. NICHOLS, chairman of the board of the Allied Chemical and Dye Corporation, past president of the American Chemical Society, the Society of Chemical Industry and the Eighth International Congress of Applied Chemistry, known for his work on the metallurgy of copper and in industrial chemistry, died in Honolulu on February 1. Dr. Nichols was seventy-eight years of age.

DR. JOHN HOWARD APPLETON, professor emeritus of chemistry at Brown University, died on February 18 at the age of eighty-six years. Dr. Appleton retired in 1914.

DR. WILLIAM OTIS BEAL, for seventeen years a member of the faculty of the University of Minnesota, and recently chairman of the department of astronomy, has died at the age of fifty-six years.

DR. GUY L. NOYES, dean of the school of medicine of the University of Missouri, died on February 4. He was fifty-seven years old.

JOHN N. COBB, dean of the College of Fisheries at the University of Washington, Seattle, died on January 13 at the age of sixty-two years.

MAX LATSHAW, Ph.D. (Johns Hopkins), died suddenly in Berkeley, California, on January 23, aged thirty-seven years. At the time of his death he was a research chemist on the staff of the Shell Development Company.

DR. ROBERT FULFORD RUTTAN, emeritus dean of the faculty of graduate studies and research at McGill University, died on February 19. He was seventy-four years old and had retired last year, after having been associated with the university since 1886. He formerly was director of the Canadian Advisory Council for Research.

DR. JAMES MATTHEWS DUNCAN SCOTT, professor of physiology in the University of Saskatchewan, died at Saskatoon on January 28.

EDWIN TULLEY NEWTON, F.R.S., until his retirement in 1905 paleontologist to the British Geological Survey and to the Museum of Practical Geology, London, died on January 28, within four months of completing his ninetieth year.

THE death is also announced of Dr. George Goudie Chisholm, Edinburgh, known for his work on geography, at the age of eighty years.

SCIENTIFIC EVENTS

THE UNIVERSITY OF CALIFORNIA ECLIPSE EXPEDITION

In answer to a request by the University of California that the army air service cooperate with Lick Observatory in observations of the total eclipse of the sun, which will be visible in California on April 28, President W. W. Campbell has received word from the United States army headquarters in San Francisco that the requisite type of plane is available, and that such cooperation will be gladly offered.

Tentative plans call for the services of one plane at an altitude of not less than 10,000 feet, over Napa Valley, between Napa and St. Helena, and perhaps of another plane equipped to take moving pictures of the eclipse shadow and of the eclipse itself.

In explanation of the cooperative plan, President Campbell says:

> The purpose of the airplane plan is to carry the observer well above the highest clouds which might be in the way of eclipse observers located on the earth's surface. The total phase of the solar eclipse will last not more than one or two seconds. The shadow of the moon on the earth's surface will be not more than one half or five eighths of a mile in width, and for an observer to locate his observing station where the shadow of the moon in its rapid northeastern travel will pass directly over him and give him the second or two of totality, will be difficult, and it is quite likely that the slight uncertainties in our knowledge of the precise position of the moon will leave many intending observers a little too far north or a little too far south to have the shadow pass over them.
>
> The sky will not be very dark at the instant of totality because the moon will succeed in just a little more than covering the sun's image. I should guess that the observers who are fortunate enough to find themselves for a second or two in the shadow of the moon could read fine newspaper print about as easily in the open air as they would a minute or two before sunset on a clear day. This estimate, however, is very uncertain, but there will be no difficulty whatever in reading ordinary newspaper print at the time and place of totality.

The university is now preparing an observing station to photograph the eclipse from the earth's surface near Camptonville, Yuba County. This expedition, which will be under the charge of Dr. J. H. Moore and Dr. D. H. Menzel, is financed by William H. Crocker, of San Francisco, chairman of the regents of the university.

The plane to be used for high altitude observations will be of the open cock-pit type, of such construction that the upper wing will not interfere with the view of the observer or of the pilot. For a few moments before and after the eclipse, the plane will fly in the direction in which the shadow moves, northeastward, in order to increase the length of time that the total eclipse may be viewed, by a little period.

It is suggested that there might be some interest in the taking of moving pictures of the eclipse, as also of the shadow on the ground, providing that it has edges sharp enough to be defined. In spite of the fact that maps have been prepared, showing the calculated path of the eclipse as accurately as possible, President Campbell points out that there is a possibility, though hardly a probability, that the shadow may be missed in spite of all precautions.

BUILDINGS OF THE YALE SCHOOL OF MEDICINE

A gift to Yale University of $400,000 from the General Education Board for the completion of the Clinic Building on the grounds of the New Haven Hospital, which is affiliated with the Yale School of Medicine, was announced by Dr. M. C. Winternitz, dean of the Yale School of Medicine, in an address to the alumni on February 22. This sum supplements the gift of $2,000,000 made by the same board a year ago for construction purposes and makes possible the completion of both the Medical and Pediatrics Laboratory and the Clinic Building.

The Medical and Pediatrics Laboratory is now under construction. It will be connected on every floor with the new Raleigh Fitkin Memorial Pavilion, to be opened on March 1, and with the isolation pavilion. Excavation for the Clinic Building has been completed and the foundation is going in. The structure will be six stories high and will contain administrative offices, kitchens, dining rooms, storage, linen rooms, history rooms and pharmacy for the entire group, as well as examining and treatment rooms for out patients. The Medical and Pediatrics Laboratory will contain offices, laboratories and teaching facilities for those men on the staff concerned with non-operative therapies. There are now lacking only four units for the complete modernization of the New Haven Hospital group. These are the ward pavilions for surgery, diseases of women and contagious diseases, and the pavilion for semi-private beds.

The need for the further development of the site of the Sterling Hall of Medicine was also presented by Dr. Winternitz. It is proposed to extend the wing of the Sterling Hall of Medicine to Oak Street and to provide in this extension quarters for the psychobiology unit under Dr. Robert M. Yerkes, as well as increased facilities for the department of physiology, especially for the work in neurophysiology to be conducted by Professor John F. Fulton and Professor J. G. Dusser de Barenne, who have recently been appointed to the staff. It is also proposed to include here gymnasium, squash courts, club rooms and locker rooms for the faculty and student body connected with the Institute of Human Relations and the medical group. Dr. Winternitz stated that a further need which is being considered is that of a dormitory to be erected on property already owned by the university for the use of students connected with the Human Welfare Group.

In speaking of developments since the Institute of Human Relations was established a year ago, Dr. Winternitz stated that great progress had been made in the selection of personnel for strengthening already well-organized units affiliated with the institute. The institute, he said, will serve as a dynamo and assembling plant for those university organizations concerned from the view-point of research, teaching or treatment with problems of human well-being. The effectiveness of the institute therefore depends upon the strength of the associated units and the program during the past year has been designed for the development of these associated interests.

Construction of the Institute Building, for which $2,000,000 was given by the Rockefeller Foundation and the General Education Board, is now well under way. It is expected that the building will be ready for use at the opening of the next academic year. It will house the department of psychiatry and mental hygiene, the graduate divisions of psychology and of the social sciences, and the child development work under Dr. Arnold Gesell.

TRIBUTE TO THE WORK OF MR. C. DAVIES SHERBORN

The following communication has been sent to the directors of the British Museum of Natural History, London:

> At the seven hundred and forty-second meeting of the Biological Society of Washington on January 11, 1930, the following resolution was passed expressing the society's appreciation of the long-continued bibliographical work of C. Davies Sherborn.
>
> Whereas, Charles Davies Sherborn, through his bibliographical researches, has made contributions of such outstanding importance in the field of zoology; and,
>
> Whereas, He has by continued and painstaking endeavor placed in the hands of his fellow-workers in the "Index Animalium" an instrument of great usefulness; and,
>
> Whereas, He has made other notable contributions such as a "Bibliography of the Foraminifera" and an "Index to the Genera and Species of the Foraminifera" and a "Catalogue of British Fossil Vertebrata," and other similar works; therefore, be it
>
> *Resolved*, That the Biological Society of Washington extends to Charles Davies Sherborn its appreciation and recognition of the service he has rendered to his fellow-workers in science.

The members of the Biological Society of Washington desire you to convey to Mr. Sherborn their most cordial greetings for his health and prosperity and wish to assure him of their continued interest in and appreciation of the value to science of the bibliographical work on which he is engaged.

A. Wetmore,
President
W. H. White,
Corresponding Secretary

NATIONAL RESEARCH FELLOWSHIPS IN THE BIOLOGICAL SCIENCES

The Board of National Research Fellowships in the Biological Sciences, which includes within its scope the fields of anthropology, psychology, botany, zoology, agriculture and forestry, held its first meeting in 1930 on February 7 and 8, and made ten reappointments and twenty-four new appointments for the academic year 1930–31, as follows:

Reappointments

For Domestic Study

Frederick Bernheim—zoology
Carleton S. Soon—anthropology
Eileen W. Erlanson—botany
G. LaVerne Freeman—psychology
Anna H. Gayton—anthropology
D. A. Johansen—botany
T. J. B. Stier—zoology

For Study Abroad

Donald Keith Adams—psychology
Paul R. Gast—forestry
Dietrich C. Smith—zoology

New Appointments

For Domestic Study

O. D. Anderson—psychology
George S. Avery, Jr.—botany
G. W. Beadle—agriculture
Harold W. Beams—zoology
Alden S. Crafts—botany
L. W. Gellermann—psychology
F. L. Howard—botany
W. E. Lammerts—botany
R. K. Meyer—zoology
Dorothy K. Postle—psychology
Daniel Raffel—zoology
Hugh M. Raup—botany
T. C. Schneirla—psychology
Eleanor H. Slifer—zoology
C. V. Smythe—biochemistry
Olive G. Stull—zoology
J. H. Tiffin—psychology
T. Elliott Weier—botany
Gene Weltfish—anthropology
John S. Yerakis—psychology

For Study Abroad

F. R. Immer—agriculture
W. M. Krogman—anthropology

C. H. McConnell—zoology
L. T. Steiger—agriculture

The second meeting for further appointments for 1930–31 is planned for about May 1 and 2, and applications for consideration at this meeting should be filed not later than April 1, and earlier if possible. Information and application forms may be obtained from the secretary, Board of National Research Fellowships in the Biological Sciences, National Research Council, Washington, D. C.

Frank R. Lillie, *Chairman*

THE INTERNATIONAL ANATOMICAL CONGRESS

The chairman of the American committee, Professor C. R. Stockard, has received the following general plan of arrangements for the International Anatomical Congress to be held in Amsterdam next summer.

The opening ceremonies of the congress will take place on Monday, August 4. From Tuesday to Friday, the mornings will be devoted to sessions for the presentation of the scientific program, and the afternoons to demonstrations.

During the congress there will be an official reception by the municipality of Amsterdam, and another general reception. The usual dinner of the congress will also be arranged. An excursion to several nearby places of interest is planned for members on Saturday, August 9.

The secretaries of the five associated national anatomical societies will receive the titles of communications and demonstrations from their respective members, and from these several lists of communications the definite program is to be arranged.

There will be exhibits of scientific apparatus, microscopes and materials by the manufacturers from various countries.

Further particulars, with lists of hotels, etc., will be sent out as soon as arrangements are completed, and those expecting to attend the congress may arrange to make hotel reservations through a local committee.

SCIENTIFIC NOTES AND NEWS

The Henri Poincaré Medal of the Paris Academy of Sciences has been awarded to Louis de Broglie for his work on wave mechanics.

On the occasion of the annual observance of George Washington's birthday by the University of Pennsylvania, the honorary degree of doctor of laws was conferred on Dr. Theobald Smith, who recently retired as director of the department of animal pathology of the Rockefeller Institute at Princeton University.

"The New York Farmers," an organization of those interested in the advancement of agriculture, has established a medal to be awarded from time to time for outstanding achievement in agriculture. The first award of this medal was made in New York City on January 21 to Dr. L. O. Howard, for more than fifty years connected with the Bureau of Entomology of the Department of Agriculture.

Dr. Curtis F. Marbut, chief of the soil survey of the Bureau of Chemistry and Soils of the U. S. Department of Agriculture, has been awarded the Cullum Geographical Medal, conferred by the American Geographical Society in recognition of services of special distinction in the field of exploration and geographic research. The presentation was made in New York City on February 25 at a banquet of the society. Major-General George W. Cullum, president of the American Geographical Society from 1877 until his death, in 1892, established the award which bears his name. The first award was in 1896, to Admiral Robert E. Peary, discoverer of the North Pole. Among others receiving it have been Fridtjof Nansen, Sir John Murray, Robert F. Scott and Sir E. H. Shackleton. Dr. Marbut's studies and classification of the soils of Europe, Africa, South America and North America have furnished an important contribution to the soil geography of the world.

The gold medal of the Chicago Geographical Society has been awarded to Rear Admiral Richard E. Byrd, for his flight over the South Pole and his contributions to the geographical study of the Antarctic. The Helen Culver gold medal was awarded to him by the society following his flight over the North Pole in 1926. Captain Roald Amundsen, discoverer of the South Pole, was the only other recipient of both medals.

Professor F. Paul Anderson, dean of the college of engineering at the University of Kentucky, was awarded the first gold medal of the American Society of Heating and Ventilating Engineers at its recent Philadelphia meeting. The medal will be given annually to the member of the society "whose work or services performed in the field of heating and ventilating or air conditioning are outstanding."

Professor E. A. Allcutt, of the department of mechanical engineering, University of Toronto, has been awarded a Herbert Akroyd Stuart Prize for his paper entitled, "Further Tests on a Two-stroke Cycle

Oil-engine," which was published in the *Proceedings* of The Institution of Mechanical Engineers, London. The prize was offered for the best paper published in the *Proceedings* within the past three years on the general subject of "The Origin and Development of Heavy Oil-engines."

Dr. Marston Taylor Bogert, professor of organic chemistry at Columbia University, was elected a foreign member of the Royal Society of Sciences of Bohemia at its recent January meeting. This organization is the oldest of the Czechoslovakian learned societies, and one of the oldest in central Europe, having been founded in the year 1770 by Czech noblemen.

The Rivers Memorial Medal for 1929 has been awarded by the council of the Royal Anthropological Institute to Mr. J. H. Hutton, of the Indian Civil Service, for his services to anthropology in the field in Assam.

Dr. J. G. Davidson, manager of chemical sales of the Carbide and Carbon Chemicals Corporation, New York City, has been elected chairman of the New York section of the American Chemical Society for 1930. He succeeds Professor R. R. Renshaw, of New York University.

Dr. Robert A. Harper, professor of botany at Columbia University, and Dr. Henry Hurd Rusby, dean of the College of Pharmacy, will retire at the close of the academic year.

Dr. Joseph S. Ames was officially inducted without ceremony into the presidency of the Johns Hopkins University at the Commemoration Day exercises on February 22. Dr. Frank J. Goodnow, president emeritus, received the honorary degree of doctor of laws.

Dr. Harry Woodburn Chase, president of the University of North Carolina, has been elected president of the University of Illinois to succeed Dr. David Kinley, who retires at the close of the academic year. Dr. Kinley has been president of the university for the last ten years and is now sixty-seven years old. Before going to the University of North Carolina Dr. Chase was professor of psychology at Clark University.

Dr. Francis P. Gaines, president of Wake Forest College, North Carolina, has been elected president of Washington and Lee University to succeed Dr. Henry Louis Smith, who has become president emeritus.

Claude Burton Hutchison, professor of agriculture and director of the Giannini Foundation of Agricultural Economics of the University of California, has been appointed dean of the College of Agriculture and director of the Agricultural Experiment Station. Howard Ross Tolley, assistant chief and director of research in the Bureau of Agricultural Economics of the U. S. Department of Agriculture, has been appointed assistant director of the Giannini Foundation.

C. A. Donnel Senior, meteorologist at the Weather Bureau, Chicago, has been appointed to succeed the late Professor Henry J. Cox.

Paul D. Kelleter, at present administrative assistant to the Federal Farm Board, is announced as the new conservation director of the Wisconsin conservation commission.

Dr. Warren M. Sperry, assistant professor of biochemistry in the School of Medicine and Dentistry at the University of Rochester, has been appointed assistant professor of chemistry, assigned to pediatrics, at the College of Physicians and Surgeons of Columbia University, and director of chemistry to the Babies' Hospital.

Dr. Robert Andrews Millikan, of the California Institute of Technology, addressed the faculty and student body of Carleton College, on January 9, under the auspices of the Sigma Xi Club. His subject, "The Alleged Sins of Science," was the same as at the recent meeting of the American Association for the Advancement of Science held at Des Moines, Iowa.

Professor K. T. Compton, of Princeton University, lectured before the Physics Club of Pittsburgh on February 12 and 13, on "The Heat Balance at Arc Cathodes," and on "Electron Emission in Accelerating Fields."

Professor Frank R. Lillie, chairman of the department of zoology at the University of Chicago, recently gave an illustrated lecture at the Scripps Institution of Oceanography of the University of California on "The Biology of Sex."

Dr. C. J. Chamberlain, professor emeritus of botany in the University of Chicago, delivered a lecture on February 1 before the Royal Canadian Institute, Toronto, entitled "Tramping through Southern Mexico."

At the invitation of Sigma Xi of Iowa State College, Professor C. W. Stewart, of the State University of Iowa, spoke in Ames on February 17 and 18 on "The Liquid State of Matter" and on "Experiments in X-ray Diffraction."

Dr. Harlan T. Stetson, director of Perkins Observatory, Ohio Wesleyan University, addressed the Franklin Institute in Philadelphia on February 13 on "The Influence of Sun-spots on Radio Reception." On February 19 he lectured at the American Museum of Natural History in New York on "Eclipse Hunting." The lecture was illustrated by slides and a film showing the actual progress of the eclipse of the sun of May 9, 1929, as photographed by his expedition in Malaya. The lecture was under the auspices of the Amateur Astronomical Association.

THE Cutter lecture on preventive medicine of Harvard Medical School was given on February 28 by Dr. Lafayette B. Mendel, Sterling professor of physiological chemistry at Yale University, on "Nutrition and Growth." These lectures are given annually under the terms of a bequest from John Clarence Cutter, whose will provided that the lectures so given should be styled the Cutter lectures on preventive medicine, and that they should be delivered in Boston and be free to the medical profession and the press.

THE fourth lecturer at the Johns Hopkins University on the Dohme Foundation was Dr. C. M. A. Stine, chemical director of the E. I. du Pont de Nemours and Company, who spoke before the chemistry staff and graduate students on February 14. He spoke on chemical research now in progress at various universities recently visited in England and Holland, with particular reference to the work of Professor Bone, chief professor of chemical technology at the Imperial College of Science and Technology in London. Following the lecture the customary departmental dinner was attended by about forty students and faculty members. Dr. A. R. L. Dohme spoke on his recent trip to Mexico. The earlier lecturers on this foundation have been Dr. C. E. K. Mees, director of research of Eastman Kodak Company; Mr. W. B. Brockway, controller of the Brown Company, Portland, Maine, and Dr. N. A. Shepard, director of chemical research of the Firestone Tire and Rubber Company.

CORNELL UNIVERSITY will inaugurate a six weeks' summer camp in geology open to ten students beginning on June 16, as a result of gifts made by relatives and friends of the late Professor Henry Shaler Williams, formerly head of the department of geology. The Williams Memorial Fund has enabled the Cornell geologists to establish a camp in central Pennsylvania, near Tyrone. The particular region is regarded as one of the best geologic sections in the Appalachian Mountains, affording unusual opportunities for the study of changes in fossil forms and sedimentation. Dr. C. M. Nevin, of the department, will be in charge of the camp.

THE U. S. Civil Service Commission states that eligible candidates are desired for the position of chief of food control, Food, Drug and Insecticide Administration, Department of Agriculture, Washington, D. C., and to insure the appointment of a thoroughly qualified man the method of competition will be as follows: The qualifications of candidates will be passed upon by a special board of examiners, composed of P. B. Dunbar, assistant chief of the Food, Drug and Insecticide Administration, Department of Agriculture; Dr. Harrison Howe, editor of *Industrial and Engineering Chemistry*, and F. W. Brown, chief of the examining division of the U. S. Civil Service Commission, who will act as chairman of the committee. For the purposes of this examination all these men will be examiners of the Civil Service Commission. The entrance salary is $5,600 a year. Higher-salaried positions are filled through promotion. Applications will be accepted by the Civil Service Commission until March 26.

DR. KARL F. MEYER, director of the University of California Hooper Foundation for Medical Research, has returned from a visit to the east, where he was called for conference with the meat packers of Chicago and other cities over botulism or food poisoning in canned meats.

NEIL M. JUDD, curator of American archeology in the U. S. National Museum, returned to Washington on February 13 from an aerial survey of the prehistoric canals in the Gila and Salt River Valleys, Arizona. Mr. Judd was sent as a representative of the Smithsonian Institution to cooperate with representatives of the Army Air Corps assigned to this survey. Lieutenant Edward Bobzien, pilot, and Sergeant R. A. Stockwell, photographer, of Crissy Field, San Francisco, flying a regulation Douglas O-2-H open-cockpit observation plane equipped with a Fairchild aerial camera, devoted ten days to the photographic work, using Phoenix, Arizona, as a base. Cloudy weather handicapped the aviators during the first week; ground haze and smoke restricted flying time to approximately two hours at midday. Mr. Judd estimates that approximately 400 miles of prehistoric main line canals and laterals were formerly utilized in central Arizona, chiefly in the Gila and Salt River Valleys. Most of these ancient canals have recently been destroyed owing to the extension of agriculture. The purpose of the survey was to prepare a mosaic map of the two valleys in order that a permanent record might be made of their prehistoric irrigation systems.

DR. A. J. GROUT, moss specialist, has been appointed to the all-year staff of the Biological Laboratory of the Long Island Biological Association, at Cold Spring Harbor. Dr. Grout has desired to retire from teaching in order to devote his full time to the preparation and publication of a series of monographs, the first of which has already been published, on the mosses of North America. An editorial board has been chosen for "The Moss Flora of North America" composed of Dr. A. J. Grout, Dr. Henry S. Conard, in charge of field botany and plant ecology at the Biological Laboratory and head of the department of botany at Grinnell College; Dr. G. E. Nichols, professor of botany and director of the Marsh Botanical Garden, Yale University, and Dr. O. E. Jennings, head of the department of botany, University of Pittsburgh. This summer Dr. Grout will represent the Biological Laboratory at the International Botanical Congress to be held at Cambridge, England. While abroad he will check up type specimens of American mosses located in European museums.

LEON M. ESTABROOK, of the foreign service of the U. S. Department of Agriculture, who for the last five years has been in charge of the World Census of Agriculture, with headquarters at Rome, has returned to Washington for a temporary assignment in the office of the Secretary of Agriculture. He will assist Dr. A. F. Woods, director of scientific work, in making arrangements with the Department of State and the Pan-American Union for the Inter-American Conference on Agriculture, Forestry and Animal Industry to be held at Washington from September 8 to 20. The conference is the outgrowth of recommendations of the Sixth International Conference of American States, held at Havana in 1928. Its purpose is to consider plant and animal production, and to develop plans for all phases of agricultural cooperation. Each nation in North, Central and South America will be asked to send an official delegate, as well as other delegates who are specialists in agricultural production and marketing. The conference will come one week ahead of the Sixth International Road Congress and it is expected that many of the delegates will attend both conferences. During the two years 1923–24 Mr. Estabrook was loaned by the Department of Agriculture to the Argentine Government to reorganize its service of agricultural economics and statistics. In the last five years in his work on the World Census of Agriculture, Mr. Estabrook visited the capitals and agricultural production centers of every country of the world with the exception of three.

UNDER the will of Mr. George de Arroyave Lopes, the executors have to hand over the residuary estate, estimated as being over £70,000, bequeathed to the Zoological Society of London, to be held by the society as the De Arroyave Fund. The income is to be applied for the upkeep and improvement of the Zoological Gardens and for the objects of the society. The society has had hitherto to depend almost entirely on the subscriptions of its fellows and on the fluctuating income from the gardens.

FIRMIN DESLOGE has made a gift of $1,000,000 to St. Louis University for the erection of a hospital.

IN preparation for the celebration of the one hundredth anniversary of the founding of Lafayette College in 1932 the board of trustees has announced a campaign for $3,500,000 for endowment and buildings. One million dollars has already been subscribed by three members of the board. John Markle, of New York, has given $400,000, in addition to the $500,000 for the John Markle Mining Engineering Hall, which was recently dedicated. Fred Morgan Kirby, of Wilkes-Barre, has given $500,000 for the Kirby Hall of Civil Rights, which will be completed in May, and Thomas Fisher, of Philadelphia, chairman of the campaign committee, has given $100,000 toward the building of dormitories and for endowment purposes.

A GIFT of the professional library of the late Dr. C. F. S. Tate to the School of Medicine of the University of Southern California and the recent acquisition of the large book collection of Dr. Charles W. Bryson have made possible the establishment of a separate medical library by the university medical school. According to an announcement by Dean William D. Cutter, the library will be housed for the present in two rooms in the basement of Bridge Hall, which are now being outfitted. The appointment of Miss Marguerite Campbell, formerly librarian of the Peking Union Medical School, Peking, China, and of the Boston Medical Library, as custodian was also announced. The library will be opened for use in a few weeks, with between four and five thousand volumes available for reference.

DISCUSSION

THE FUTURE OF TAXONOMY

I HAVE just received a statement from the secretary of the Zoological Society of London, calling attention to the inadequacy of the support given to the *Zoological Record* and hinting that unless conditions improve it may be necessary for the Zoological Society to abandon the enterprise. I use the *Record* almost daily, and find it so essential for my work that I am greatly alarmed at the prospect of its discontinuance. In my own case this would not be so serious as in the case of a younger worker, with perhaps half a century of work ahead. To him it would mean, first of all, a great increase in the time consumed in bibliographical work; and secondly, reduced accuracy in his work, as he would certainly miss important publications.

What are the reasons for the present state of affairs? To some extent, I think, the competition of *Biological Abstracts* is responsible. The *Abstracts* covers a large field not dealt with by the *Zoological Record* and in this field is simply invaluable. But its zoological taxonomy appears to me to be not only very incomplete, but also from its manner of publication of comparatively little use. For my own work I find it practically useless. I understand that it was seriously considered that this part of the *Abstracts* might be dropped, and it seems to me that this should be done. As long as it is there, librarians and officials, and even heads of departments, will imagine that it covers the field adequately, and that the *Zoological Record* is unnecessary.

There is, however, a deeper and more important reason for the non-support of the *Record.* It is the lack of interest in taxonomy. For this, I believe, our graduate schools are largely responsible, and perhaps it is not too much to say that in certain respects the graduate school is an enemy of sound science. This is due to the system, not to any particular fault on the part of those who administer it. Consider what we have. A great and increasing number of candidates for the M.A. and Ph.D., together with other less popular degrees. They overrun the departments in the large institutions, and the problem for the professor is to find subjects which these people may study, and on which they can write an acceptable thesis, in one to three years. The actual time available is much less than this statement might suggest because these students have other things to do, and very commonly are employed in the teaching, often handling all the quiz sections and correcting all the examination papers. In this situation, what subjects of research may be profitably chosen? Those which (1) require little previous knowledge, and (2) involve no great breadth of view. It must not be necessary to accumulate a special collection or library, and it is very important that the student should not bother the professor too much. As a typical example, I think of a brilliant girl I know, who was set to cutting off the tails of salamanders, in order to find out whether (under laboratory conditions, certainly not in the wild!) they grew any faster without a tail to support.

I do not mean to say that most of these theses do not possess some value, at least for those doing the work, and it is true that occasionally an important taxonomic monograph, involving many years of study, is accepted for the Ph.D. But broadly speaking neither the spirit nor the methods are those of profound scientific research; and taxonomy, which requires many years (if only that the worker may discover his own mistakes), is out of the question.

What have we left to rely on? We should expect and demand that the scientific departments of the government prepare monographic works on various groups, especially those of economic importance. Some very good work of this type has appeared, but I think not nearly enough. To be concrete, I do not see any valid reason why the Bureau of Entomology, with its really enormous appropriation and abundance of technicians of all sorts, has never given us a monograph of the Coccidae (scale insects and mealy-bugs).

Yet all that the governments can do is not enough, and it would be deplorable if the progress of science depended wholly on governmental agencies. There remains the amateur, the man of the type and spirit of Darwin and Wallace, who loves science and finds in it the means of satisfying the cravings of his mind, intellectual and emotional. It is the amateur who can rejoice in his slowly increasing collection, in the increments of his knowledge. Though he may spend only a few hours a week at his hobby, he becomes a learned man with the passage of time. When there are enough amateurs in a district, they form a society, a fellowship of the disciples.

There is no simple way to attain all these good things. But the first step is to desire them, and if we do that long enough and earnestly enough they will be realized in abundance.

T. D. A. COCKERELL

UNIVERSITY OF COLORADO,
DECEMBER 20, 1929

RECENT CRITICISMS CONCERNING MEIOSIS IN DROSOPHILA MELANOGASTER

FOR the past few years some rather strongly adverse criticisms have been made by E. C. Jeffrey, in which he claims that the meiotic divisions of *Drosophila melanogaster* are atypical, resembling those of certain species hybrids in plants, and that this fly is therefore also a species hybrid.

Nobody who has worked with *Drosophila melanogaster* has taken Jeffrey seriously in respect to his statements. Being eminent in paleobotany, his venture into a specialized field of animal cytology seems to be a long and daring step. Any one familiar with the elementary laws of genetics can readily perceive the inaccuracy of his assertions. I do not intend to answer him on his latest contribution in SCIENCE of December 13, 1929, but I do feel that the cytologic status of *Drosophila melanogaster* should be briefly submitted to those readers of SCIENCE who are not specially versed in cytology or genetics. Having followed Jeffrey's periodic attacks since 1925, I have no desire to enter into any controversy with him, and my interest in this matter will end with this brief statement. A detailed account of the spermatogenesis of *Drosophila melanogaster* is now ready for the press and will be published in the *Archiv für Zellforschung und mikroskopische Anatomie.*

It may be well advised to discuss first the merits of methods employed. Professor Jeffrey claims that he obtains better preparations with Carnoy's mixture than with Flemming's. It is true that one may obtain fairly good material with Carnoy's, if the duration of fixation is definitely ascertained within the limit of a few minutes. But it is a very tricky fixing agent and for this reason is not as reliable as Flemming's or many other mixtures which are in general use. Flemming's solution is superior to any other fixing agent in its constancy of delicate preservation, and this point of view is held by most cytologists who have worked with *Drosophila melanogaster* (Belar, Bridges, Frolowa, Metz, Stern, etc.). Carnoy's may be an excellent fixative in plant cytology, but it certainly has a limited use in animal cytology. It must also be pointed out that a fixing solution which is good for one species is not necessarily the same for others, and Jeffrey's criticism that Belar used Carnoy's for Nematodes and avoided it for Drosophila demonstrates his inexperience in the methods of cytologic technique. I also must take exception to the assertion that Flemming's fluid does not preserve mitochondria. It was this very fixative which gave rise to the investigation of mitochondria, and our modern work in this phase of cytology is accomplished chiefly by a modification of Flemming's fluid from which the larger part of acetic acid has been removed.

Several years ago (1924) I described the maturation phenomena in the egg of *Drosophila melanogaster.* The first meiotic spindle is present when the spermatozoa enter. Within twenty minutes the polar bodies are formed, and the maturation divisions are so plainly visible in this large egg that I have used such preparations for classroom demonstrations. If Jeffrey's assertions were true and *Drosophila melanogaster* were a species hybrid, the atypical condition in meiosis should show itself most definitely in the meiosis of the egg and not be confined to the spermatogenesis alone.

To consider *melanogaster* a hybrid would necessitate the same view for other Drosophilae, certainly *obscura, virilis, Willistoni* and *funebris,* since their cytology is of the same type as that of *melanogaster,* and also that they give rise to many mutants. Many geneticists have tried to cross closely related Drosophila species with *melanogaster* without success (Morgan, Metz, Sturtevant, etc.). I spent the greater part of one year in such experimentation, going so far as to inseminate the unfertilized egg by means of a micropipette, without being able to secure normal development. All such eggs degenerated in a short time. The interspecific sterility in all Drosophilae is so pronounced that the possibility of ever obtaining viable species-hybrids has been abandoned by most geneticists. If Jeffrey's comparison of *Drosophila melanogaster* to species-hybrids of certain plants were true, where are the two possible species from which *melanogaster* could have been derived? Why is it impossible to cross *melanogaster* with *Willistoni* or *caribbea,* two species which are morphologically and cytologically so much like *melanogaster* that only an expert can tell them apart?

In 1926 Metz published an account of the spermatogenesis of *Drosophila virilis,* including his observations on *melanogaster* and several other species. Though I am inclined to disagree with him in minor details, in the main his figures are correct and are in line with other observers. He showed that meiosis takes place in a normal, typical manner. There is also no doubt about the correctness of Belar's interpretation of the primary spermatocyte. However, it is absurd for Jeffrey to take Belar's figures 5a, 5b, and 5c on plate II of his "Die cytologischen Grundlagen der Vererbung" for the purpose of substantiating his assumptions. These figures represent three aspects of one cell in the first meiotic division, and Jeffrey makes a strong point of the fact that one chromosome is situated on one side, behind the others. Having examined hundreds of such divisions, I have observed this chromosome many times. In 1909 it was identified by Miss Stevens as the XY combination. I have traced it from diakinesis through the first meiosis to the secondary spermatocytes and found it to lag during the entire process. Lagging sex chromosomes are so common in spermatogenesis that such behavior is the rule rather than the exception. It is due to this lagging that Bridges explained non-disjunction which occasionally occurs in *Drosophila melanogaster.*

In addition to the XY complex, the primary spermatocyte contains three other bivalents. Two of these can be readily recognized, but the third consists of chromosomes so small as to resemble a small dot. To make an issue over a chromosomal arrangement in an "equatorial plane" with lagging sex chromosomes and only two fairly large bivalents is to overreach oneself in unimportant detail. But in spite of Jeffrey's assertions to the contrary, the bivalents do come to the approximate center of the first spermatocyte spindle and separate there into univalents. Belar's photograph 5a shows this condition splendidly. The division of the secondary spermatocyte takes place after an interkinesis. The univalents are there separated into four chromatids, so definite in outline that their identity and number can be ascertained without question.

Jeffrey's divergent results from those of the large number of cytologists who have worked on *Drosophila melanogaster* must be ascribed to his inexperience in Drosophila technique. Judging from his figures, published in previous papers, he apparently mistakes certain cell inclusions which stain black with iron hematoxylin for chromosomes. This difficulty can be overcome when the Feulgen nuclear reaction, preceded by formol-alcohol-acetic acid fixation, is applied.

I wish to repeat that this account is not written in a controversial spirit, but is merely given as a point of information. I also fully realize that the geneticists could disprove Jeffrey's assumptions even better and more effectively than a cytologist, but I doubt whether any one of them would take the time to do so.

Since this article has been written, Guyénot and Naville have published a most thorough account of the spermatogenesis in *Drosophila melanogaster* in *La Cellule*, Vol. xxxix, No. 1, 1929. They also repeated my investigations on maturation divisions of the egg in which they agree entirely with my work. Their criticism of Jeffrey's work is almost a duplicate of mine given above.

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THE "FERTILIZATION" MEMBRANE OF ECHINID OVA

IN SCIENCE[1] for October 11, 1929, Professor A. R. Moore contributes a note on "The Function of the Fertilization Membrane in the Development of the Larva of the Sea-urchin." Against his conclusion I wish to enter a protest.

I had supposed that even beginners in marine embryology realized that the "fertilization"—vitelline—membrane of echinid ova plays no rôle in development after its complete separation from the vitellus. Every such student knows that by centrifuging, pressure, and the like, uninseminated ova of the sea-urchin are easily deformed—can, for example, be pulled out into long strands—with a return to normal form. This is due to the elasticity of the closely adherent vitelline membrane which encloses the almost watery egg contents and which plays a rôle in the metabolism of the egg. After insemination not only does the membrane stand off from the egg; it becomes stiff, brittle and easily removable; it has changed chemically, as Harvey has shown, and it plays no part in the metabolism of the egg. Removal of the membrane (except by micro-dissection?) from the uninseminated egg is practically impossible. Its removal after insemination has been frequently accomplished and this without injury to the egg or impairment of development. Finally, every student of the living sea-urchin egg has doubtless observed its "hatching," *i.e.*, the escape of the swimming form through the ruptured membrane. What justification, then, has Moore for the conclusion in his note concerning the function of the vitelline membrane in development?

Perhaps Moore did not mean the vitelline ("fertilization") membrane. In that case he should have given his note a different title. If, on the other hand, he meant the hyaline plasma layer the statement in his conclusion is superfluous; here again, every student knows that the hyaline plasma layer is part of the developing egg.

In his experiments, Moore finds that after exposure to an isosmotic solution of urea (he does not give the pH of the solution) uninseminated eggs are capable of fertilization and development without the "formation" of either the "fertilization" or hyaline membrane. Obviously, this might mean simply that the preformed cortex which during and after membrane separation builds up the hyaline plasma layer is so injured by urea that the normal cortical changes underlying the separation of the vitelline membrane are abnormal. The result would then be not the failure to "form" hyaline plasma layer but the rapid disintegration of this layer after it "forms."

If Moore's interpretation of his experiment on the effect of urea—namely, that it inhibits formation of the hyaline plasma layer—be correct, then he has been most unfortunate both in the choice of his title and in the statement of his observations.

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PEDOLOGY OR SOIL SCIENCE

IN reply to the comments of Dr. William A. Hamor in the January 17, 1930, issue of SCIENCE relative to the use of the term *pedology* to refer to soil science, attention should be called to the fact that pedology was first used by the Russian soil scientists in 1865, over thirty years before the child scientists adopted it. The latter, as Dr. Hamor notes, are using an incorrect spelling of the word. The term they should employ is *paedology* or *paidology*. In view of the prior use of pedology to refer to soil science and as the psychologists are using the word incorrectly and also because of the general acceptance and use of the term in Europe in place of soil science, the American Soil Survey Association at its annual meeting in Chicago in November formally adopted the term. No other terms suggested are even being considered. Those mentioned by Dr. Hamor are obviously out of the question. It is well known that the child scientists have been using the word, but if they will spell their word correctly there will be no difficulty. Of course it is not expected that any such term will immediately come into general use instead of soil science, which appeals to many of us as quite satisfactory. Perhaps it may never be generally used. But we can be sure that it will be used to some extent from now on in research work, at least.

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[1] 70: 360.

P. E. Brown

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QUOTATIONS

MEDICAL EDUCATION IN AMERICA

The third report of the influential American Commission on Medical Education dealt with general principles. In a supplement to the third report a critical summary is given of some of the changes in procedure which have been put to a practical test in a number of the American schools of medicine, and serve thereby to illustrate certain of the general principles of training emphasized in the earlier report. The schools are referred to by letters of the alphabet, and not by their names, and without considerable knowledge of the local conditions it is therefore very difficult to identify them. The former period of two years' pre-medical work has now been extended to three or even four years in most of the better schools of medicine, which can easily fill their classes with college graduates; and as 95 per cent. of the graduates follow their medical course of four years by a hospital internship of one to two years, it takes about ten years from the date of entering college for the student to become financially independent. The cost of medical education is naturally going up, and the fees paid by students supply, as shown by the average of the figures from sixty-three schools, little more than one third of the total, the difference being met by endowment and from other sources. In the sixty-three schools, 42 per cent. of the budget goes to provide salaries for the whole-time teachers, and 6 per cent. to part-time teachers. During the last few years the total amount of work, as shown by the number of hours required, has been somewhat reduced in the majority of schools; thus in thirteen schools which in 1925 demanded 4,000 or more hours, there has been an average reduction of over 400 hours, but there are wide variations; in twenty schools taken at random the hours required for anatomy varied from 1,267 to 480, for medicine 1,030 to 428, for surgery 660 to 332, and for gynecology and obstetrics 368 to 168. Although much consideration has been given to uniformity and standardization, there is probably far more variation in the curriculums at different schools than is generally assumed. Three types are described. The first is the orthodox standardized curriculum of recent development, intended to familiarize the students, who all take the same courses, with every phase of medical knowledge; the amount of instruction is heavy, and the staff is small. The second type is represented by a small number of schools closely allied with universities, having few students, who have much more freedom, working on graduate rather than on undergraduate lines; and specializing early; the teaching staff is large, and there are full-time clinical instructors. The third group is intermediate between the other two, and offers a comprehensive training for all and special opportunities for a limited few. Teaching in pharmacology is becoming less concerned with pharmacy and more with the physiological action of drugs, thus forming a bridge between physiology and therapeutics. Clinical-pathological conferences, in which the physician in charge of the case first gives the clinical history and diagnosis, and the pathologist then shows the post-mortem conditions, are well established at some schools, as are joint demonstrations of surgical problems by surgeons and anatomists. Efforts are made to remove the reproach that the student does not know how to deal with the sick person; thus at one school 15 per cent. of the fourth-year students follow the daily work of a general practitioner for one or even two months. The teaching of preventive medicine throughout the curriculum is gaining ground, and it is pointed out that pharmacological instruction might well deal with patent medicines and the mischief they do to patients who attempt to treat themselves at a stage when early diagnosis and proper treatment may prevent serious consequences.—*The British Medical Journal.*

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN INNOVATION IN SCALE CONTROL

Incidental to a study of the effect of dusting citrus trees with extremely finely divided sulphurs for possible control of the citrus thrips, the discovery has been made that a very high mortality of the citricola scale (*Coccus pseudomagnoliarum* Kuw.) has accompanied the use of these sulphurs. The groves where these tests were conducted are located in the San Joaquin Valley—one of the hotter regions of California.

Dusting citrus trees with sulphur has been practiced for a number of years in southern California against the citrus mite, but evidently no records of scale control by this method are to be found. The daily maximum temperatures for southern California are decidedly lower, as a rule, than is the case in central California where our tests were made. At Lindsay, for example, where most of our data were secured, the mean maximum temperature for June is 94.9° and for July is 101.4° Fahrenheit (U. S. Weather Bureau). These high temperatures probably constitute the factor which causes the scale mortality through the accelerated sublimation of the sulphur particles.

TABLE I

MORTALITY OF CITRICOLA SCALE BY DUSTING WITH VERY FINELY DIVIDED SULPHURS

Grove	Type of sulphur	Number of applications	Date of scoring grove	Net scale mortality
Montague White	Gas-purification	2	June 14*	100.0 per cent.**
H. A. Campbell	Commercial yellow	2	" 15	90.1 "
A. T. Margo	"	2	July 7	97.5 "
"	Gas-purification	2	" 7	91.6 "
C. C. Chapman	"	2	" 24	96.1 "
I. A. Baldwin	"	3	" 25	100.0 " **
Frank Kennedy	"	3	Aug. 8	98.3 "
Paul Gramm	"	2	Sept. 11	97.2 "
"	Commercial yellow	2	" 11	96.5 "
"	"	3	" 13	96.7 "
Montague White	Gas-purification	3	" 20	96.7 "
E. I. Brown	"	3	" 23	98.6 "

* All dates are of 1929.

** Had larger series been employed these values no doubt would have dropped below 100.0 per cent.

Average mortality for 3 dustings .... 98.1 per cent.
" " " 2 " .... 95.6 "
" " " all jobs .... 96.6 "

The above table briefly summarizes our data bearing on the subject of scale mortality induced by applications of sulphur dust to citrus trees.

In further explanation of the table it should be recorded that all the dustings were applied between April 15 and June 14, inclusive. The period during which the scale hatched was from May 12 to about July 15, so that the sulphur applications were effective against the "crawlers" throughout most of the hatching period.

The gas-purification sulphur consisted of a mixture of 20 per cent. of sulphur recovered in the process of purifying city illuminating gas and 80 per cent. commercial yellow sulphur. In all cases the sulphurs employed were ground to the point where a high percentage of the material would pass through a 200-mesh-per-inch screen, and the majority of the particles through a 300-mesh screen.

The mortality percentages listed in the table do not include natural mortality from climatic or other causes. Each of the groves had an untreated check which provides the basis for the mortality computation.

It is planned to prepare a more complete manuscript to be submitted at some future time dealing with this highly interesting new method of scale control.

E. A. McGREGOR

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CULTIVATION OF BACTERIUM TULARENSE

THE literature contains numerous references to the difficulty encountered in the cultivation of *Bacterium tularense*. Francis has shown that this organism grows well on serum dextrose cystin agar. This medium may be prepared by a process simpler than the somewhat complicated method used by Francis. Medium prepared by the process given below produces abundant growths of *Bact. tularense*, even with primary isolations.

Dissolve 0.05 per cent. cystin in water containing 0.2 per cent. Na_2HPO_4, with the aid of heat; add this to dehydrated heart infusion agar to which 1 per cent. dextrose has been added; heat the whole in the water bath to dissolve the agar. If cystin dextrose agar is desired, tube and sterilize at fifteen pounds steam pressure for fifteen minutes. Should serum cystin dextrose agar be desired, sterilize the medium in a flask at the above pressure for the same time, then cool to 50° C., add 5 per cent. sterile rabbit's blood serum, tube and slant.

Frederick W. Shaw

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SPECIAL ARTICLES

THE EFFECTS OF INFRA-RED, VISIBLE AND ULTRA-VIOLET IRRADIATION ON CHANGES IN ELECTRICAL POTENTIALS AND CURRENTS IN PLANTS

Many theories have been developed to account for the effects of ultra-violet and infra-red radiations on tissues. We cite: (1) the activation of cholesterol in the skin, (2) the ionization of calcium and phosphorus in superficial tissues, (3) the electrical modifications produced in the proteins of the skin and consequent changes in hydrogen-ion concentration and (4) the presence of fluorescing materials in the skin which may act as absorbers of energy of short wavelength with reemission in the form of energy of longer wave-length which, in turn, is utilized by the tissues either as heat or in chemical changes.

The skin is the medium which separates the organism, whether it be an animal or a plant, from its environment. The skin, therefore, is the medium of reception of radiant energy and the seat of transformation or utilization of the incident energy. Since no changes of a physical or chemical character are produced in cells, tissues or organisms unless there is an absorption of energy, and since protoplasm exercises a pronounced absorption of energy of short wavelengths (such as ultra-violet rays) and of the shorter infra-red radiations which lie close to the region of the visible spectrum, we have felt that an investigation of the electrical changes produced in the leaves of living plants under various types of selective radiation might give some information regarding the physical and chemical changes taking place in plant tissues when exposed to these various kinds of energy.

Potentiometric changes produced by artificial sources of radiant energy.—Sunflowers were used in general for experimental purposes outdoors during the summer; poinsettias were found satisfactory for indoor investigation during the autumn and winter months. Ordinarily electrodes of thin tinfoil were used and attached to the leaves or stems of plants by means of acid-free kaolin after the method of Sen. In investigating potentiometric changes in leaves, both before and after irradiation, one electrode was fastened near the base of the leaf and the other one was placed at or near the tip of the leaf. Leads were then carried to a Leeds and Northrup potentiometer, using a high sensitivity galvanometer. Various spectral filters, such as Corning Glass Company filters of special make and transmitting only infra-red, red, green, blue and ultra-violet rays and so forth, respectively, were employed. Infra-red energy of long and relatively short wave-lengths could be removed from the sources of illumination by water chambers of sufficient depth and possessing quartz bottoms. The visible and infra-red portions could be removed by water cells and solutions of certain substances or by special mediums transmitting selected portions of the ultra-violet light only. The artificial sources of energy used were infra-red generators and arcs rich in ultra-violet irradiation.

The data obtained during the last three years definitely show that marked changes in electromotive forces in leaves are produced by irradiation with infra-red and ultra-violet rays. The potential changes under heat rays from an infra-red generator are usually rapid and values as high as 0.3 volt change in potential have been obtained. The potential changes produced by irradiation with an air-cooled quartz-mercury lamp have been similar to and in the same direction as those produced with infra-red irradiation. The visible portions of the line spectrum of air-cooled quartz-mercury arcs operated at 90 volts did not produce changes, except possibly small changes in the region of the short visible waves (violet end of spectrum). Irradiation with quartz-mercury arcs from which the infra-red energy had been removed by suitable water filters, hence allowing the incidence of visible and ultra-violet rays only, produced potential changes in the same direction as those produced by infra-red rays and of an order ranging from 0.005 to 0.10 volts. These data show that potentiometric changes are produced by infra-red and ultra-violet irradiation.

Potentiometric changes produced by ionized gases near arcs.—Ozone and oxides of nitrogen produced by the quartz-mercury arc or by other metallic arcs, operating at high voltages, through which air was drawn, the ionized or nascent gases then being conducted through suitable channels to the container surrounding the leaf under test, showed marked potentiometric changes and in the same direction as the changes produced by infra-red or ultra-violet irradiation. These observations lend support to the theory which we are advancing that ionization, due directly to ultra-violet light or indirectly to the ionized condition of the gas (air) which forms the medium surrounding the leaf, is largely responsible for the potentiometric changes observed.

Potentiometric changes produced by sunlight.—During the summer of 1929 series of experiments were conducted in which observations, covering periods of eighteen to twenty-four hours, were made simultaneously on the relative humidity, temperature, electromotive force (voltage) and intensity of illumination of sunlight (foot-candles), using sunflowers which were living and growing outdoors. From the data obtained it is apparent that there is a close correlation between changes in temperature and differences in electromotive forces developed in the leaves of sunflowers. Auxiliary experiments, in which relative humidity and temperature could be kept constant while admitting sunlight through ordinary glass windows with southern exposures, were conducted on plants living and growing constantly indoors. These auxiliary experiments showed that there was a definite correlation between the intensity of solar energy incident on the leaf used and the potentiometric differences developed. The conclusion, therefore, apparently is warranted that the changes in electromotive force are dependent on the infra-red portion of sunlight. The absorption of solar infra-red radiations by the atmosphere and the earth's surface produces changes in temperature. Plants also absorb such infra-red radiation. As a result, therefore, it is not the direct influence of temperature as such, but the absorption of energy from a body (the sun), which is an efficient source of radiant energy at a high temperature, that causes changes in electromotive force.

Changes in electrical current.—Voltages from 22.5 to 45 volts were applied at the electrodes attached to a leaf and the currents read with a micro-ammeter. In general, the values of the currents were of the order of 25 to 50 millionths of an ampere, indicating that the resistances of the leaves were approximately a million ohms each. The currents, under such condition, fall away asymptotically with time. When the approximately steady state of electrical current was reached, leaves were irradiated successively with various portions of ultra-violet, visible and infra-red radiations. The experimental data show that both ultra-violet and infra-red rays (from sources of fairly high temperature radiation) produce increases of current or corresponding decreases of resistance, while various selective regions of visible light produce little if any change. There is evidence, therefore, that stimulation by ultra-violet and infra-red rays produces an increase in ions in the leaf and that there may be a change in permeability of membranes.

Spectrophotometric changes.—The spectrophotometer built by Keuffel and Esser was used in the study of the changes in color produced in leaves when exposed to radiation of various qualities and quantities. The type of water-cooled attachment, devised by Brunsting and Sheard, carrying the magnesium carbonate block which serves as a standard for reflection of light, was employed in this work because it enabled us to obtain spectrophotometric measurements from living leaves, intact with the plant, over as many periods and under as many conditions as desired.

After a few minutes' exposure of a given area (usually 2 by 4 cm) on a leaf (intact plant) to infrared irradiation it was found that considerable darkening of the exposed area occurred shortly after irradiation. The degree of this darkening increased with time until it finally reached a steady state. Repeated exposures of various leaves of different plants to irradiation with red, yellow, green and blue portions of the visible spectrum did not produce changes in spectrophotometric reflection. Ultra-violet rays, especially those below the limit of sunlight (practically speaking, 300 millimicrons), produced a definite bronze or brown-black effect in general. Hence plants, as well as human beings, get a browned and darkened epidermis by exposure to ultra-violet rays. Microscopic examinations showed that these effects were accompanied with a breaking down of the outer layers of cells of the affected areas.

CONCLUSIONS

(1) Marked changes in the differences of potential between the base and tip of leaves intact with plants can be produced by ultra-violet and infra-red radiations.

(2) No change in differences of potential in intact leaves can be observed under irradiation by selected portions of visible light or by the total visible energy of sunlight, with the possible exception of energy possessing wave-lengths lying at the extreme violet and red ends of the spectrum.

(3) In general, the difference of potential between the base and tip of the leaf, when the plant is kept continuously in darkness or subdued daylight, is such that the base of the leaf is relatively positive with respect to the tip of the leaf. The greatest difference of potential (base positive and tip negative) arises when the plant is kept in darkness.

(4) Under high artificial illumination or under noon-day sunlight, when the plants are housed behind ordinary window glass, the difference of potential decreases and the tip of the leaf may become positive relative to the base of the leaf.

(5) Very marked and rapidly produced differences of potential in leaves may be obtained by exposing the leaf (with electrodes protected) to gases drawn from the vicinity of quartz-mercury or other metallic arcs.

(6) From the data obtained relative to humidity, temperature, foot-candles of illumination and potential differences in leaves of plants (sunflowers) growing outdoors, it is concluded that these electromotive forces between base and tip of leaves are due chiefly to infra-red radiations.

(7) When an external and constant electromotive force is impressed on the leaf across the two electrodes, the values of the currents in the circuit including the leaf are increased by either ultra-violet or infra-red radiation or the values of the resistances are decreased.

(8) No measurable changes in currents under an impressed electromotive force are produced in leaves when exposed to various regions of visible light.

(9) Leaves may be darkened or tanned by ultra-violet or infra-red radiations. The character of the bronzing or tanning effect is apparently somewhat different in the two cases. Both ultra-violet and infra-red rays, however, possess the ability to fix the chlorophyll in the tissues, probably by disruption of cells and localized dehydration of surface tissues.

(10) From these experiments and other investigations which have been conducted on germination of seeds, growth of plants and development of chlorophyll, we conclude that the phenomenon of growth is evidenced, in part at least, by changes in electromotive force, and is largely dependent on and stimulated by the ultra-violet and infra-red regions of sunlight. The visible portions of sunlight are used, in all probability, for the development of chlorophyll.

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THE MANGANESE CONTENT OF THE MISSISSIPPI RIVER WATER AT FAIRPORT, IOWA

The fact that the normal growth of plants, in many instances, depends on the presence of small amounts of certain metals is fast becoming apparent. Felix (1927)[1] reported that the application of copper improved certain muck soils on which onions and lettuce were raised. Brenchley (1910)[2] found that manganese stimulated the growth of barley, and Deatrick (1919)[1] found that manganese prevented chlorosis in wheat.

It was with these results in mind that the writer undertook to investigate the manganese content of the Mississippi River water at Fairport, Iowa. The Mississippi River furnishes the water for the fish ponds at this place. It was thought that possibly manganese might be a *limiting factor* in the production of algae in the fish ponds.

In Table I are given the results of some manganese determinations made during the summer of 1929. The results show that while the quantity varies considerably from time to time, there is always an appreciable amount of manganese present. It does, therefore, not seem likely that manganese was a limiting factor.

TABLE I

Showing Amount of Manganese in Parts Per Million. The Letter S Refers to Surface Samples, the Letter B to Bottom Samples

Date	Parts per million	Date	Parts per million
5/24/29	S. .044	9/21/29	S. .120 B. .120
6/12/29	S. .106	9/27/29	S. .080
7/2/29	S. .055	10/5/29	S. .128 B. .100
7/16/29	S. .075	10/12/29	S. .096 B. .088
8/7/29	S. .114 B. .084	10/19/29	S. .080 B. .072

The results shown in Table I were obtained from samples of filtered water, and they presumably represent the manganese that was in solution and not the total manganese.

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U. S. Biological Station,
Fairport, Iowa

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[1] Raber, "Principles of Plant Physiology," Macmillan, 1928.

[2] *Ann. Bot.*, 24: 571, 1910.

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THE RELATION OF ANTHROPOLOGY TO INDIAN AND IMMIGRANT AFFAIRS[1]

By Dr. FAY-COOPER COLE

CHAIRMAN, DIVISION OF ANTHROPOLOGY AND PSYCHOLOGY NATIONAL RESEARCH COUNCIL

FORTY-THREE years ago the Bureau of American Ethnology was formed to collect all the data possible concerning the surviving Indians in various parts of our country. Since that time, departments of anthropology in various universities have been turning out highly trained men who have devoted years to intensive study of the American Indian. Studies have been made of his physical type, his susceptibility to disease and the effects of race crossing, as well as of the development of his diverse cultures from earliest times to the present. The Bureau of American Ethnology alone has issued over 180 monographs and bulletins dealing with the American Indian and his culture, while the publications of other institutions would easily double that number.

With such a mine of information at the disposal of those who have to deal with our aborigines, we should have the most enlightened policy of any nation in the world. What are the facts? In searching the records of Congress which deal with Indian affairs, there is little evidence that that body realizes it has a great research organization at its disposal. A scrutiny of the boards of Indian commissioners in recent years reveals the names of few men who are recognized as authorities on Indian life and custom, while the administration of the Indian Office has often been entrusted to men ignorant of, or indifferent to, Indian customs. Occasionally men of highest ideals have been placed in positions of authority, but they have found themselves overwhelmed with advice from those having special interests in the Indian.

One group urges that we break down the old religion and customs as rapidly as possible; and to bring this about would forbid the old dances and celebrations, would break up the reservations, would allot the land and force the Indian to "swim or sink," believing that necessity will force him into American life.

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[1] Address of the retiring vice-president and chairman of Section H—Anthropology, American Association for the Advancement of Science, Des Moines, December 30, 1929.

Another group exalts the life of "the noble Red Man," and would leave him unchanged, forgetting that the conditions which made the old life possible have been, for the most part, destroyed.

Between those who would perpetuate the reservations and those who would abolish them, between those who would found more Indian schools and those who would put all the children into the public schools, between those who would make the Indian subject to state laws and local courts and those who would judge his crimes according to tribal law—it is no wonder that the newcomer in the field is in a daze; and by the time he begins to learn something of actual needs and conditions he finds a new administration in power, and himself displaced.

Little wonder then that our Indian service lacks a well-trained personnel and that it has been the subject of severe criticism. Little wonder that the Indian has come to look with suspicion on every move which is made for his "betterment."

But it is not the Indian service alone which is groping in the dark for a solution of the Indian problem. A few weeks ago the speaker attended a conference on the Indian. At this session were men and women representing various missionary boards, the Indian Rights Association, the Indian service and similar organizations. A carefully arranged program, evidently intended to bring out the interests of all groups represented, resulted in a series of papers on individual or local problems or discussions of the Indian problem in the light of a single field. A few of the speakers appeared to have a wide grasp of the situation, but it was apparent from the discussion which followed that their excellent presentations made little impression.

It is easy to criticize. It is easy to point out the shortcomings of others. But we anthropologists must realize that something is radically wrong with us if, after forty years of intensive research and the publication of numerous books, we have made so little impression on Congress, on the Indian service, on missionary boards and other Indian workers.

Let us take stock for a moment and see what is wrong. Is it in the training of the workers? Have the studies been shown to be inaccurate or untrustworthy? Has there been any suspicion that we are serving special interests? I think not. Our studies are accepted as being accurate and thoroughly objective; but right here may lie our chief weakness. Not long ago a woman from another field complained that anthropology had succeeded in becoming objective, but in the attempt had lost its soul. Perhaps she is right. We have been so intent on gathering and recording facts that we have had little time to generalize, and when we have generalized it has been along the lines of scientific interest rather than those of practical, every-day life.

We have demonstrated to the scientist the regional character of culture, the dynamics of cultural growth, the effects of environment, of diffusion and of convergence; but we have not been equally successful with the layman. In other words, we have failed to sell our goods to the people who are meeting the Indian problem at first hand.

Is this inevitable? Is it impossible to make anthropological investigations of value to the government, to the missionary and to those who wish to have economic relations with the less advanced peoples?

When America entered the Philippines, the administration of the Interior Department of the islands was given to the Honorable Dean C. Worcester, a man who believed that if you wished to be successful in ruling a people, you must know their background, their social, economic and religious life. Almost the first step taken toward gaining this information was the founding of the Bureau of Non-Christian Tribes, and an ethnological survey. A real attempt was made to understand the people of a region before we extended our government to them, and it was sought to make our laws conform as closely as possible to the customary law of the region. The result was the establishment of friendly relations with nearly all the pagan tribes and a minimum of bloodshed.

Our neighbors to the north of the Philippines, who sought to impose their rule on a similar people, but without this preparation, have met with bitter opposition and are now waging a war of extermination against the hill tribes. In the island of Sumatra the Dutch sought to extend their rule into the Padang Islands, the country of the Menangkabau. They sought to follow the same methods as they had pursued in Java; namely, that of strengthening one of the petty chiefs and through him ruling the country. But the scheme failed, and for two hundred years Holland made little headway. Finally, following a serious rebellion in 1907, they decided to try a different system. A group of anthropologists was sent to the region, instructed to gain all possible information concerning the life and beliefs of the people, and especially to learn the *Adat*, or customary law. I have not time here to cite the situation which they found more than to indicate that, despite the fact that the Menangkabau are closely related physically and linguistically to the people of Java and live in adjacent territory, they have a system of descent, of government and ownership of property so radically different from that of Java that no single system of control could be expected to cope successfully with both.

By 1911 the Dutch had learned enough of the situation to attempt again to penetrate the country, this time through friendly advances rather than through force; and when I was in the country in 1922 and 1923, I found a half dozen Dutch officers and 100 Ambionise soldiers controlling without difficulty more than a million and a half of the tribesmen.

In the northern part of this same island, the Rhennish mission undertook the work of conversion of the Battak, a powerful cannibal tribe which had offered constant opposition to the white man. Under wise leadership, these missionaries sought first to learn the native life, then to modify it so as to remove the most savage customs yet disturb the old as little as possible. The motto often quoted to me was: "Destroy only when you have something with which to replace." There the work was so successful that they made more than 100,000 converts among one of the most savage tribes in all Malaysia. Then came the World War. Many of the missionaries were withdrawn, and for months, in some places for years, the converts were left without guidance. Yet we found them conducting their services and continuing the new religion without let-up. The missionaries had succeeded in so merging the old and the new that there was no question of reversion to old conditions.

On a nearby island we found quite the opposite situation. Here the missionaries were of a different mind. Their motto was: "Destroy the old so as to establish the new." Old customs were derided; the old faith was shattered, instead of being incorporated; the power of the chieftains was broken, and the schools sought to instruct the children along European lines. Then came the war and the withdrawal of the missionaries. With old customs and faith shattered and with the old control gone and the new teachers removed, a most chaotic condition prevailed. Ashamed to return to the old life and yet not fitted to the new, the people drifted spiritually and economically into a hopeless condition, and at the time of our visit presented only the shattered remnants of a culture which a few years before was recognized as one of the most advanced of primitive civilizations.

Here we have presented a conspicuous success and a dismal failure, and the reasons are evident. You can not rule a people, you can not adapt a new faith or a new culture to a people, unless you know their background. You can not build a successful, self-respecting society on an inferiority complex.

I should like to cite one more instance. There has recently come to my attention the work of the British schools in the former German territory north of Lake Tanganyika in Africa. Here the aim is to establish an educational system based on native custom, yet which will introduce such modifications as will fit the individual for the social and economic changes which follow contact with Europeans. The first six months were given over to an anthropological survey of three closely related tribes. Friendships were established, the cooperation of chiefs and elders secured, while the knowledge of local institutions made it possible to merge old and new without in any wise destroying the self-respect of the natives. The first native institution to be employed was that of *wigendo* or the calling of boys and young men to the courts. For ages past it has been the right and duty of the chiefs to summon a large number of youths to court where they served while they were being instructed in tribal lore and crafts. The second institution was the counsel of elders. In each district there is an elder who is authority on native tradition. It is his duty to guide the ruler and his people, and to rebuke those who err from custom. With the support of the chiefs, the youths are summoned and the elders join with the white teachers as instructors. They teach the traditions of the tribe, assist in maintaining discipline and also act as counsel to discuss and settle difficulties.

By using these old institutions, a link has been forged between the old and the new. The cooperation of the older generation has been secured, and the pride of the boys in their race and customs has been fostered. Instruction is planned so that it continues the past interests, yet adds to them. The boys are taught improvements in hygiene, in standards of life; they are given instruction in agriculture and animal care in addition to normal academic instruction. However, care is taken not to make the break too great or too sudden. They begin with simple native methods and advance as rapidly as possible. They build houses and school buildings, following native types and using native materials, but adding such modern improvements and conveniences as are available or can be produced locally. Too often natives are instructed in the use of materials and devices which are beyond their means when they leave school, but all the advances learned in these schools are available when they return home, and thus they are able to introduce new aids and comforts into the native villages. The aim has been to build on those aspects of native life that are important and enduring, and from these to develop new forms of activity that will fit for contact with Europe, yet will preserve pride of race and tribe. The experiment is still in the early stages, but the full cooperation of the chiefs has been secured, and the schools have constantly grown.

The Dutch in the Indies, the British in Africa and Malaysia, have learned that the only successful way to deal with the natives is to have the administrators versed in native lore and custom and to govern as closely as possible in accordance with the established code. We have found the same to be true in the Philippines, and it is to be hoped that we will ultimately realize that this will apply equally well to our Indian problem.

I have just said "Indian problem" but there is no such thing. Rather, we have a series of problems. We can not correctly speak of the American Indian, if by this we mean to imply that economically, culturally or religiously he is everywhere the same, or even similar. Every student of ethnology knows that there are several well-defined culture areas north of Mexico, and within these there are many tribal and local variations. The instruction and guidance which will fit the sedentary Pueblo Indian has at present little practical value or interest for his seminomadic neighbors. It is useless to teach the Navajo how to build good houses without attempting to reach and modify the belief that a dwelling must be destroyed or abandoned upon the death of a member of the family. It is neither wise nor right to deny the Indian the privilege of conducting a native dance by means of which he hopes to influence the powers which control the rain or which produce fertility. This has often been advocated, but the sponsors should realize that by so doing they not only kindle native resentment, but having forced the rites into secret practices have really strengthened their hold on the native mind.

It is only by following such a policy as that of the British in Africa which I have cited that we can slowly shape and modify native life and customs. It is, of course, true that in some regions the native life is shattered, the customs and beliefs have largely lost their hold and the Indians are living much like white men. It is likewise true that in many such regions we find the greatest disorganization; the native has been taught to despise the old, yet he is not fully accepted into the new, and like a raft in a storm he is carried hither and yon without aim or purpose. Some individuals succeed in spite of such handicaps, but the majority sink below the level of their white neighbors and become liabilities rather than assets.

American anthropology has proved beyond a doubt that the American Indian is not an inferior being, either physically or mentally. A late arrival on this continent, he was pioneering while Europe was far advanced toward civilization. Without domestic animals other than the dog and turkey, he steadily advanced in culture until in Middle America he achieved a real civilization. He constructed great cities; he built pyramids and temples which rival those of Egypt and Greece; he invented a written language and was far advanced in astronomy and mathematics; he developed agriculture and gave to us a large number of the domestic plants which now form the basis of our economic life. I might cite his metal working, wood-carving, weaving, pottery and other crafts, but enough has been said to indicate that potentially the Indian is capable of great advance, if given the proper guidance. Every monograph on Indian life will show many elements which should be preserved and which can be used in building for the future. A great amount of material has been collected; it now becomes our duty to make it available to those who can apply it.

It should be our aim to lend helpful cooperation to all agencies working in behalf of the American Indians, and this we can do without sacrificing the high scientific standards which we have established.

There is still another problem of great importance to our nation in which anthropology should make contributions of great importance. That is the immigrant problem. Until a few years ago the majority of the newcomers to this country were drawn from northern Europe, and the similarities of speech and custom made it easy for them to merge into our population. But with the influx of southern Europeans we suddenly found that we had to absorb peoples with backgrounds very different from our own. We did not understand them and they did not understand us, and the result has been the settlement of such peoples in compact communities in which they perpetuate old world customs and feuds, and their participation in American life has been long delayed.

The same situation is rapidly developing with the Mexican who is coming to us in ever-increasing numbers. That anthropology can give us an understanding of these peoples is conclusively shown by the background studies carried on in Mexico and Sicily. In these studies the investigators have lived for months in regions from which we have been drawing immigrants and have sought to gain a clear insight into the social, economic and mental life. With this information available we are able to understand what happens when known cultures meet; we are able to direct the newcomers and aid in their absorption into our life. Such information at once becomes available to the economist, sociologist, political scientist, welfare worker and others who are interested in social studies.

I have given my topic as "The Relation of Anthropology to Indian and Immigrant Affairs," but I might have extended the discussion to child development, to problems of growth and dentition, to race mixture, to criminology and to many other fields closely linked with our investigations.

Anthropology has contributed much to our knowledge of man and his culture in all ages; it must now give more attention to the application of this information to present-day problems.

We must sell our goods. We must convince the practical workers in these fields that we have something they need for the solution of their problems. We can aid the government officer, the social worker, the missionary, the teacher, as well as our fellow scientists. We can have the same satisfaction in seeing our carefully gathered facts put to practical use as the worker in pure science has in watching his discoveries applied to industry.

THE GRAY HERBARIUM CARD INDEX

By Professor B. L. ROBINSON and LESLEY C. WILCOX

GRAY HERBARIUM, HARVARD UNIVERSITY

For twenty-six years the staff of the Gray Herbarium has compiled and published a card catalogue of the newly described and renamed plants of America. The work was undertaken in order to continue a similar card index which had been begun and carried through about ten years by Miss Josephine A. Clark, who at the time was librarian of the U. S. Department of Agriculture. The history of the undertaking has never been recorded in print and may be summarized as follows:

An experimental study preliminary to the enterprise was the publication by Miss Clark of a list of such phanerogams and vascular cryptogams of the North American continent as had been newly published or renamed during the year 1891. This list was compiled by Miss Clark under the supervision of the late Dr. J. N. Rose, and appeared in the Contributions from the United States National Herbarium i. 151–188 (issued September 20, 1892). At that time the "Index Kewensis" had not yet appeared and the importance of Miss Clark's list was immediately evident. It was welcomed as the first of a series likely to be continued each year. However, for several excellent reasons it was decided that the catalogue would have much greater convenience and utility if it could be issued at more frequent intervals and be printed on cards so that the successive parts could be readily arranged in a single alphabetic sequence or, at the wish of the subscriber, be separated into systematic or geographic groups. It was also felt that it should include the new plants, not merely of North America, but of the whole American continent and the adjacent islands.

After due consideration and with the encouragement of the botanists at the Department of Agriculture and at several other centers of botanical activity, Miss Clark undertook such a card catalogue. Her first expectation had been to restrict it to the higher plants in the manner of her first list, but she was urged by the cryptogamists of the department, especially by the plant pathologists, to include also the cellular cryptogams. This she did, it is believed, rather reluctantly, realizing the great difficulties involved.

Miss Clark's catalogue was issued in twenty instalments beginning early in 1894 and continuing to 1903. These issues ranged from 920 to 2,144 cards each. The catalogue was printed on cards of the then current library size, namely, 5 x 2 inches, a form which it has never seemed desirable to change. The plan of the work was to have (1) a card for each newly characterized American genus, species, subspecies, variety or other named form, the scientific name appearing in full and being followed by the name or recognized abbreviation of the name of the author, together with a bibliographical reference to the place of publication and a very brief statement of range, (2) a card for each scientifically renamed American plant with similar bibliographical reference to the place in which the new name or combination was published, followed by explanatory synonymy, (3) a cross-reference card indicating in each case of transfer the name-bringing synonym, followed by the new name, (4) a blue card (long since discontinued) of the same size indicating the title of each work indexed, (5) reprinted cards when needful to supplement previous synonymy and references and (6) correction cards (issued without charge) to emend any detected errors.

Very soon after the Card Index had been begun, the first part of the great "Index Kewensis" appeared, a work which was to list the genera and species of phanerogams of the world published up to the end of 1885. It then became one of the primary purposes of the Card Index to furnish American botanists with an effective supplement to this more universal work. Therefore, the attempt was made to carry the Card Index back to the beginning of 1886, an undertaking which, with all practicable endeavor, it has not been possible entirely to accomplish.

Miss Clark was much aided by the collaboration of Mrs. Alice F. Stevens and, in the later part of her work, she employed also in the indexing of certain works the assistance of Miss Mary A. Day, who was then the librarian of the Gray Herbarium. By 1903, however, Miss Clark's duties as librarian of the Department of Agriculture had so increased that she desired release from further care of the Card Index and most generously handed it over with its good-will and subscription list to the Gray Herbarium, where its importance was particularly appreciated and where Miss Day, already trained in its methods of work, could carry it forward consistently and effectively.

When turned over to the Gray Herbarium, the Card Index contained 27,999 cards. Miss Day, from 1904 until the middle of 1923, did most of the indexing, though she had from time to time aid from other members of the Gray Herbarium staff, especially from Miss Edith M. Vincent, who through many years assisted her. In 1923, when, toward the close of her life, her work on the Card Index was given up by Miss Day, the number of cards had been advanced to about 170,000. Since the autumn of 1923, the Card Index has been conducted by Miss Lesley Chillingsworth Brown (now Mrs. Lesley C. Wilcox), appointed bibliographer of the Gray Herbarium largely for this complicated duty. Mrs. Wilcox has had aid in her work, especially in the assembling of the literature to be indexed, in the interpretation of doubtful references and in critical verification, from nearly all the other members of the Gray Herbarium staff, as the time at their disposal or their special acquaintance with difficult groups rendered their services available or particularly needful, Dr. I. M. Johnston having given special aid on the side of the now copious Spanish- and Portuguese-American botanical literatures. At present the Card Index has run to 124 quarterly issues, together including 199,011 cards.

From its beginning until 1909 the cards were sold at the uniform rate of $15 per thousand. Since that time, on account of the very greatly increased cost of printing, it has been necessary to raise the price to $22.50 per thousand. It may be said at this point that although the sale of sets to the subscribers has somewhat more than defrayed the cost of printing, the returns have never fully covered the expenses of compilation, not to mention the great amount of salaried time employed in the critical verification. As the index has thus been sold at less than cost, it naturally has not been feasible to reduce its price.

To date no less than 375 botanical journals and scientific serials have been indexed, as well as about 350 monographs which have not appeared in serial form. The catalogue has covered works in no less than fifteen languages. So very numerous have been the individual papers which have received attention that it has not been found feasible to continue Miss Clark's system of issuing the blue cards to record their titles.

The largest single lacuna in the work of the index arises from its inability to cover to date a considerable part of Dr. Otto Kuntze's "Revisio Generum." In this work the often rather arbitrary and artificial renaming of plants created thousands of new names and new combinations, many of them being applicable only under the rules individually devised by Dr. Kuntze and sanctioned by no widely accepted code. To have introduced these names and combinations at any one time into the Card Index would have so extended the issues as to have rendered their cost prohibitive to subscribers. It has therefore been thought best to introduce these names gradually, only a hundred or so at a time, when the issues were not otherwise crowded. In this manner these competing names, at least so far as the phanerogams and vascular cryptogams are concerned, can ultimately be recorded and in a manner less burdensome to the subscribers.

It long ago became evident that the indexing of the cellular cryptogams involved well-nigh insurmountable difficulties. Notwithstanding the best endeavors which could be put forth the cryptogamic indexing fell very much behind the completeness and efficiency of the phanerogamic, and at the end of 1927 it was found impracticable to continue it. The reasons for this change may be briefly stated as follows. Cryptogamic botany for many decades has been growing highly specialized. Its groups are so unlike in their nature as to require very different methods of investigation. From the standpoint of research it may be said that cryptogamists, as such, have ceased to exist. They have been replaced by specialists who restrict their activities to particular groups—to the mosses, hepatics, algae, the lichens, fleshy fungi or pathogenetic fungi. As a result such specialists have little experience or interest in the general bibliography of the cryptogams, and consequently it was found impossible to secure collaboration in this undertaking without subdividing the work beyond practical limits. Inquiry of the subscribers showed that the majority of the establishments which were purchasing the Card Index were using it primarily, if not exclusively, for its information relative to the phanerogams and vascular cryptogams. No one of these subscribers showed much interest in incurring the very large expense which would have been entailed if the index were brought to date on the cryptogamic side. Not only would this have very greatly increased the cost of the index to subscribers, but it would, so to speak, have inconveniently diluted it and rather lessened its convenience for those consulting it chiefly in connection with phanerogamic and pteridophytic work.

Further inquiry developed the fact that cryptogamic specialists had little interest in the index because many of them developed for their own purposes more effective special lists of the particular groups on which they are working.

Finally it was found that much of the newer publication upon the cellular cryptogams runs to a complexity far beyond the powers of accurate interpretation on the part of any indexer who is not particularly acquainted with the group concerned.

For these very cogent reasons it was felt that the Card Index could neither satisfactorily bring to date its indexing of the cellular cryptogams nor run the risk of proving misleading by any inadequate presentation of these groups. The change was made reluctantly and with the hope that the botanists occupied with the cellular cryptogams may effect in their field some similar undertaking which will far better meet their needs.

The cost of the index to each subscribing establishment which has kept its subscription continuous from the beginning has been $3,389.62. The index is now being regularly taken by seventeen establishments,[1] five of them being governmental, and two being in Europe. It will be readily understood that the work is of a kind which proves exceedingly useful in connection with a large botanical library and at establishments where taxonomic research on American plants is in progress.

The majority of American botanical investigators confine their researches to American plants, and for them this index possesses several elements of particular convenience; among these, promptness of issue is one of the most important. A very large part of the publications which include American plant-novelties are received and indexed within three months of their publication, and the issue of the Card Index which contains reference to such publications comes out, as a rule, within six months of the appearance of the papers covered. The index has the further advantage that it covers not merely the flowering plants, but the ferns and their allies as well, which, of course, is not true of the "Index Kewensis" and its admirable supplements. The Card Index lists not merely the genera and species, in the manner of the "Index Kewensis," but also subspecies, varieties and named forms. The cross-reference cards in the Card Index are also a source of much convenience and quick information, since they indicate each old name which has suffered replacement or transfer. Finally, the Card Index has the inestimable advantage that it permits the ready arrangement of all these names in a single alphabetic sequence.

Unhappily the work is of a nature in which it was quite impossible to carry an edition which would permit much reserve for the future. Some of the early issues were exhausted many years ago. About two thirds of the whole is still available in a very few sets.

For some years the issues have run rather evenly to about 1,200–1,250 cards per quarterly issue. This brings the average cost of the index for subscribers to about $110 per year.

Even those recent subscribers who have not attempted to acquire the back issues have given assurance that they were finding the index very helpful in drawing to their attention papers which had not come to their notice, but were significant to their work.

No one who has not actually engaged in a bibliographical undertaking of this nature would suppose that new species could be hidden in places so obscure as those in which they are sometimes found, as, for instance, in school programs, college dailies, sporting and outing journals, town and county histories, etc.

Before closing this account we wish to express very cordial appreciation of the volunteer assistance which has from time to time been sent by botanists interested in the completeness of the Card Index; special aid in this matter has come from the U. S. National Herbarium, the Department of Agriculture, New York Botanical Garden, Field Museum, Missouri Botanical Garden and from the great herbaria at Berkeley and Stanford University in California.

In view of the fact that the Gray Herbarium, without any educational grant or other subvention, has been carrying for twenty-six years and is continuing this widely useful work at the sacrifice of much time and at some financial loss, it seems justified in urgently requesting cooperation on the part of the authors and editors who publish work including new American plants. Such aid may appropriately take two forms. In the first place the indexing can be accomplished much more easily and completely if authors take proper pains to indicate clearly all new plant-names so that these may be caught by the bibliographer without undue trouble, many such names and combinations having been in the past so obscurely put forth that their actual novelty can be ascertained only by prolonged researches into synonymy and previous literature. In the second place authors of new American plants or new names for American plants, at least among the phanerogams and vascular cryptogams, will confer a great favor by sending copies of their papers to the Gray Herbarium as soon after publication as possible. The result will be an early indexing of the novelties and incidentally a wider publicity for the papers themselves, thus adding much to their usefulness and prompt scientific recognition. It may be pointed out that such cooperation on the part of individual authors will contribute effectively to their mutual convenience.

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[1] The list of present subscribers includes: Arnold Arboretum; Botanical Museum at Berlin-Dahlem; Carnegie Museum; Field Museum of Natural History; Gray Herbarium; John Crerar Library; Missouri Botanical Garden; New York Botanical Garden; Royal Botanic Gardens, Kew; Stanford University; Library of the U. S. Department of Agriculture; Department of Botany of the U. S. National Museum; University of California at Berkeley; University of California at Los Angeles; University of Minnesota; University of Wisconsin, and Victoria Museum, Ottawa.

A few words may here be said on the care and use of the Card Index. When received by subscribers each issue has its cards in alphabetic order, but then has to be incorporated into the index as a whole. This process is one which requires close attention, for not only should the alphabetizing be exact, but much care should be taken to remove from the index all those cards which are being replaced. These are of two kinds: (1) those which have been found defective and are to be replaced by the cards definitely labeled "corrected reprint," (2) those cards which are to be replaced by others furnishing not merely the same information, but one or more added synonymic cross-references.

To keep the index as accurate, clear and compact as possible, it is highly essential to remove promptly and permanently these cards which have been corrected or superseded. So rapid is the growth of synonymy and so frequently do transfers occur that the cards which have to be reprinted to show these matters become very numerous. The removal of cards replaced for these causes reduces the bulk of the index as a whole by about 9 per cent., an element to be taken into account in its compactness, convenience and the lessened drawer space needful for its setting up.

To insure against slip or error, it is wise to preserve, in a separate place and at least for some years, all cards thus taken out. If stored in alphabetic sequence these removed cards may at any time be subsequently consulted if question arises whether some of them may not have been taken out accidentally and by error.

In any form of revisional or monographic work upon a group of plants, the index is immediately found to be invaluable. It not only serves to indicate the recently published species of the group, but, what is accomplished by no other single source of information, a list of the newly published propositions in the subspecific categories. Furthermore, it furnishes immediate clues to the recent literature dealing with the groups themselves. In classificatory papers very few of extent or significance fail to put forth some description of plant novelties or some correction of plant names. The Card Index, by recording such novelties and transfers, thus becomes, incidentally, an admirable subject index for the systematic botanist and covers a high percentage of the literature important to his activities.

Issues 1 to 55 (1894–1912) were printed by H. N. Patterson, of Oquawka, Illinois, at that time well known as a skilful printer of botanical labels, lists, etc. From issue 56 to date the Card Index has been printed, alphabetized and mailed by the Library Bureau, Cambridge, Massachusetts.

Any communications regarding the Card Index should be addressed to The Bibliographer, Gray Herbarium, Cambridge, Mass.

OBITUARY

JOHN ROBERT BENTON

DR. JOHN R. BENTON, dean of the College of Engineering of the University of Florida for nineteen years and a member of the faculty since the establishment of the institution at Gainesville in 1905, died on January 8, after an illness of only five days. He was fifty-three years of age. Death was due to pneumonia growing out of an attack of influenza.

Dean Benton was a leader in the engineering field in the United States. He was the author of twenty-four books, the last of which, "An Introductory Textbook on Electrical Engineering," was published in 1928. Born at Concord, N. H., his education was received at Trinity College and the University of Chicago, and abroad at the University of Göttingen and the University of Berlin. He received his B.S. and B.A. degrees from Trinity in 1897 and 1898 and his Ph.D. degree at the University of Göttingen in 1900.

Dr. Benton was a member of Phi Beta Kappa, Phi Kappa Phi, Sigma Xi and Theta Chi fraternities, and of many scientific and professional societies and associations, including the American Physical Society, the American Institute of Electrical Engineers, American Association for the Advancement of Science, the American Association of Engineers, the Society for Promotion of Engineering Education, the National Electric Light Association and the Florida Engineering Society. The Benton Engineering Society is an organization of University of Florida engineering students.

Prior to going to the University of Florida, Dr. Benton occupied positions on the engineering faculties of Princeton and Cornell Universities.

He was one of the most beloved citizens of Gainesville, having been prominently identified with the city's progress during his years of residence there.

RECENT DEATHS

Professor Hector J. Hughes, dean since 1920 of the Harvard University School of Engineering, died on March 1, at the age of fifty-nine years.

Mary Whiton Calkins, professor of philosophy and psychology at Wellesley College, past president of the American Psychological Association and of the American Philosophical Association, died on February 27, in her sixty-seventh year. Dr. Calkins had been associated since 1888 with Wellesley College, where she established one of the first laboratories of psychology.

Dr. Joseph M. Hirsh, formerly teacher of chemistry at Cooper Union, New York City, who is said to have discovered the process for the recovery of sugar from beet-roots, died on February 13 at the age of eighty-seven years.

Dr. Johannes Govertus de Man, of Yerseke, Holland, died at Middelburg on January 19, at the age of seventy-nine years. He was a foremost carcinologist and had published several hundred valuable contributions on Crustacea. He was formerly conservator of the Rijks Museum of Natural History of Leyden, officer of the Order of Oranje-Nassau and officer of the Order of Cambodje.

MEMORIALS

Mrs. Prince has given $15,000 for the building and endowment fund of the Boston Medical Library as a memorial to the late Dr. Morton Prince.

A memorial plaque to the late Sir William Glyn-Jones, formerly secretary of the Pharmaceutical Society of Great Britain, who died on September 9, 1927, was unveiled in the society's examination hall by the Right Honorable Christopher Addison on February 5.

Tribute to the memory of the French mathematician, Pierre de Fermat, is to be paid by the French Academy of Sciences, whose members have ordered his bust to be placed between two other great mathematicians of his period, Descartes and Pascal.

SCIENTIFIC EVENTS

AGRICULTURE IN ENGLAND

An investigation into the present state of English agriculture has been completed by the Institute of Agricultural Economics of the University of Oxford. The London *Times* states that the report of the investigation, which has just been issued, points out that

> over a large part of the country considerable difficulty will be experienced in finding any farm to be let, and, moreover, when one is to become vacant, there are perhaps dozens of applications for it. Even the moderately intelligent observer can scarcely fail to ask himself the reason. Is it probable that only the best farms come into the market? That is scarcely credible, because the good farms are too rare to be lightly vacated. Is it only the poorer and more inconvenient, in fact the marginal farms, which are changing hands, and, if so, is it to be supposed that there are so many men, men who have been born to the land and know of its present difficulties, who are anxious to plunge themselves and their families into financial perdition?
>
> What is true beyond all question, is that in some parts of England there is not a farm to be let, and only by offering him a figure in excess of market prices can the tenant be persuaded to give up his holding—he credits a large amount of his assets to good-will. It is equally true that in other parts of England there are farms being carried on by the owners for want of any tenant, farms which have been offered rent free for two and three years without success, and still no working farmers will come forward to invest their capital in them. In other words, although our national agriculture can not be considered prosperous, yet, at the same time, to affirm its general depression is both unwise and untrue. The problem is essentially one of districts, of types of farm and types of farming. For the purposes of the inquiry it was deemed that the course of farm rents, combined with a consideration of the demand for farms or the difficulty of obtaining tenants, in this district or that, would show for England what the rural land market might show in another country.

From the information thus obtained it is declared by the report that depression can not be said to exist in the west, and, conversely, the returns from the eastern parts of the country show the hardships under which the farming community is laboring. English agriculture is not suffering from one simple disease, and there is no one simple remedy which can be applied. The report concludes that:

> (1) Some commodities, such as milk and market garden stuffs, are produced, owing to their highly perishable nature, under naturally protected conditions. Where advantage is taken of this natural protection farmers find themselves on a substantial basis of prosperity. Further, where immediate proximity to a consuming center makes it possible to combine production with direct retailing the farmer is peculiarly fortunate, and the complaint is less of depressed agriculture than of depressed industry and the consequent contracted purchasing power of the consumer.
>
> (2) Other commodities, such as corn and meat, enjoy no such natural protection or marketing advantages, but

are produced in direct competition with oversea farmers. This competition is being met successfully: (*a*) by those who tend to conform to the practice of the farmers in the New World, by an extensification of methods, taking little more from the land than nature gives, and in no way seeking to force production; (*b*) by those who occupy land "good enough to eat," which can be relied upon under almost any conditions to give a full return on the capital and labor expended upon it. It is being met with less success by those on certain types of soil, who are seeking to carry on established systems of farming under economic conditions which to-day leave them no margin on their expenditure.

(3) Apart from commodities, and to a lesser extent, perhaps, of soil types and farming systems, farmers who are able to operate their holdings without recourse to hired labor on any considerable scale are meeting the conditions of the times without difficulty.

THE CHARLES LATHROP PACK FELLOWSHIPS IN FORESTRY

THE Charles Lathrop Pack Forest Education Board, founded by the Charles Lathrop Pack Forestry Trust of Washington, D. C., announces a number of fellowships in forestry for the year 1930–31. The purpose of the fellowships is to encourage men who have shown unusual intellectual and personal qualities to obtain training that will best equip them for future leadership either in the general practice of forestry, in the forest industries, in the teaching of forestry, in forest research or in the development of public forest policy.

The awards will be made to gifted men who demonstrate natural powers of intellectual and personal leadership, and who intend to make forestry their life work. The sum of $10,000 is available the first year. The awards will range from $500 to $2,500, or more in exceptional cases, and will ordinarily be restricted to men of American or Canadian citizenship. No restrictions are made as to age, educational status or practical experience, but great emphasis will be placed on character, intellect, qualities of leadership and similar qualifications.

The administration of these fellowships has been placed in the hands of the Charles Lathrop Pack Forest Education Board, which is composed of the following: *Chairman,* Henry S. Graves, dean, School of Forestry, Yale University; *Secretary,* Ward Shepard, U. S. Forest Service, Washington, D. C.; Samuel T. Dana, dean, School of Forestry and Conservation, University of Michigan; John Foley, purchasing agent, Pennsylvania Railroad, Philadelphia; Arthur Newton Pack, Princeton, New Jersey, director, Charles Lathrop Pack Forestry Trust; E. O. Siecke, director, Texas Forest Service, College Station; Ellwood Wilson, chief forester, Laurentide Division, Canada Power and Paper Corporation, Grande Mere, Quebec; Hugo Winkenwerder, dean, College of Forestry, University of Washington, Seattle; Raphael Zon, director, Lake States Forest Experiment Station, St. Paul, Minnesota.

Application forms and other information can be obtained from the secretary of the Charles Lathrop Pack Forest Education Board, 1214 Sixteenth Street, N. W., Washington, D. C. For the current year the completed applications must be in the hands of the secretary not later than April 15. The awards will be made at the next meeting of the board, which will be held in New York City on May 10.

APPROPRIATIONS FOR GRANTS-IN-AID BY THE NATIONAL RESEARCH COUNCIL

AT meetings of the National Research Council's Committee on Grants-in-Aid, held in December and February, twenty-eight appropriations were made from the special fund recently placed in the hands of the Research Council for the aid of research, chiefly through allotments to individual investigators. This committee is composed of the chairmen of the seven divisions of science and technology of the council, together with the chairman of the council, the treasurer and the permanent secretary. The grants made were as follows:

Margaret Harwood, director, Maria Mitchell Observatory, for the measurement of light of variable stars and the computation of periods of variation; Leonard B. Loeb, associate professor of physics, University of California, for a study of the mechanism of the spark discharge; A. H. Pfund, professor of physics, Johns Hopkins University, for the measurement of radiant energy from Brownian movement; Frank Schlesinger, director, Yale University Observatory, for observation of parallaxes and proper motions of bright stars in the southern hemisphere; Arthur H. Warner, instructor in physics, University of California at Los Angeles, for studies of the photoelectric effect from clean tungsten surfaces.

John B. Whitehead, professor of electrical engineering, Johns Hopkins University, for investigations on the fundamental dielectric properties of insulating oils.

William Lester Gilliland, instructor in chemistry, University of Maine, for studies of the properties of carbon monoxide; Linus Pauling, associate professor of theoretical chemistry, California Institute of Technology, for the determination of the electron distribution in various crystals.

T. Addis, professor of medicine, Stanford University Medical School, for a study of hypertrophy and compensatory hypertrophy with respect to renal disease; C. Sidney Burwell, professor of medicine, and Glenn E. Cullen, professor of biochemistry, Vanderbilt University, for investigations on tissue changes in cardiac edema; L. R. Corecedo, assistant professor of biochemistry, University of California, for investigations on the purine fraction of the nucleic acid molecule; E. A. Doisy, professor of biochemistry, St. Louis University School of

Medicine, for studies of the ovarian hormone; Harry Goldblatt, associate professor of pathology, Western Reserve University, for study of the growth of malignant tissue in vitro; Yandell Henderson, professor of applied physiology, Yale University, for assistance in his studies of the treatment of pneumonia by inhalation of carbon dioxide; William de B. MacNider, University of North Carolina Medical School, for study of the pharmacology and toxicology of white snake root; William C. Rose, professor of physiological chemistry, University of Illinois, for investigations on the nutritive importance of the amino acids.

E. B. Babcock, professor of genetics, University of California, toward the expenses of a collecting expedition for the study of the taxonomy, cytology and genetics of the genus *Crepis*; R. A. Brink, associate professor of genetics, University of Wisconsin, for investigation of the cytological and genetic bases of semi-sterility in maize; Ralph E. Cleland, associate professor of biology, Goucher College, for cytological and genetical studies of *Oenothera*; George M. Reed, research curator, Brooklyn Botanic Garden, for part of the expense of a trip to Japan for the study of varieties, culture and diseases of the Japanese iris.

Thomas R. Garth, professor of educational psychology, University of Denver, for a study of the incidence of color-blindness among Indians; Melville J. Herskovits, assistant professor of anthropology, Northwestern University, for study of the anthropometry and heredity of the American Negro; Arthur Randolph Kelly, assistant professor of anthropology, University of Illinois, for anthropometrical and morphological studies of the Cherokee Indians; Maurice G. Smith, associate professor and head of the department of anthropology, University of Oklahoma, for a study of the peyote cult among the Indians of Oklahoma; Roland C. Travis, Western Reserve University, for experimental investigation of the speed of reflex and voluntary eye movements.

Division of Anthropology and Psychology of the National Research Council, for part of the expenses of a preliminary study of the development of Negro children (jointly with the Social Science Research Council); Division of Anthropology and Psychology of the National Research Council, for part of the expenses of a conference on culture areas (jointly with the Social Science Research Council); Division of Chemistry and Chemical Technology of the National Research Council, for expenses of Professor Austin M. Patterson, of Antioch College, in connection with a meeting of the International Union of Pure and Applied Chemistry on the Reform of the Nomenclature of Organic Chemistry.

Of these twenty-eight grants, one was for the sum of $2,000, and two were for $1,500 each. Eight grants were made for $1,000 each, nine were for sums between $500 and $1,000, and eight for sums of $500 or less.

VERNON KELLOGG,
Permanent Secretary

THE ATLANTA MEETING OF THE AMERICAN CHEMICAL SOCIETY

CHEMISTRY'S advance in the south will be a dominant theme at the seventy-ninth meeting of the American Chemical Society, which will be held in Atlanta, Georgia, from April 7 to 11. More than 1,500 scientific men from this and other countries will attend. Five hundred papers and addresses will be presented outlining the progress in chemical science.

The opening event will be a session of the council on Monday afternoon, April 7, when plans to meet the expanding activities of the society, now, with more than 17,000 members, the largest professional organization of its kind in the world, will be discussed. The president of the society, Professor William McPherson, of the Ohio State University, will preside.

The most pressing need of organized chemistry, according to Dr. Charles L. Parsons, who will submit his annual report as secretary, is an endowment of several millions of dollars to finance the society's publications. Scientific and industrial research is developing so rapidly that the income of the society is no longer sufficient in itself to record it.

To keep American science and industry abreast of knowledge in chemistry, the society has developed a reporting system, centering at the Ohio State University, which covers the world's entire chemical literature, and the results of which are embodied in a publication called *Chemical Abstracts*. The number of periodicals from which digests are made for American use now exceeds 1,500.

At a general meeting on Tuesday morning, April 8, under the auspices of the Division of Industrial and Engineering Chemistry, which will usher in the scientific sessions, industrial chemical processes as practiced in the south will be featured.

On the same day the Division of Physical and Inorganic Chemistry, headed by Professor W. V. Evans, of Northwestern University, will hold a symposium on "Analytical Chemistry." Among the speakers and their topics are: Professor G. L. Clark, University of Illinois, "X-Ray Analysis"; C. C. Nitchie, the New Jersey Zinc Company, Palmerton, Pennsylvania, "Spectrographic Analysis"; C. W. Mason, Cornell University, "Microscopic Methods"; Professor V. K. LaMer, Columbia University, "Modern Methods of Solutions." Other speakers at this symposium will be Professor H. B. Weiser, director of the department of chemistry, Rice Institute; Professor I. M. Kolthoff, University of Minnesota; Professor N. H. Furman, Princeton University, and Professor H. H. Willard, of the University of Michigan, secretary of the division.

In a public address on Wednesday evening, April

9, closing a day of divisional sessions, Dr. Harrison E. Howe, editor of *Industrial and Engineering Chemistry,* will deliver a public address on "Chemistry Comes South." Another event stressing the development of chemistry in the southern states is a symposium on "The Relation of Cotton to Chemical Industry," to be held by the Division of Chemical Education. Experts from all over the country will take part. Dr. Charles H. Herty, past president of the society, will preside.

Practically all the professional divisions will meet in Atlanta. Public health, the growing alliance of chemistry and medicine, chemical education, nationwide popular training of women in chemistry, rubber, gas and fuel, sugar, petroleum, cellulose, history, agriculture and food, biology, paint and varnish, and water, sewage and sanitation are among the topics to be discussed.

The Division of Biological Chemistry will hold sessions on the relation of vital processes in health and disease, including nutrition, vitamins, irradiation, endocrinology, proteins, amino acids and enzymes. Graduate and undergraduate students will join with teachers from schools and colleges all over the country in the sessions on chemical education.

Mineral waters will be the chief topic of discussion at the sessions of the Division of Water, Sewage and Sanitation Chemistry. The papers at one session will deal with the application of the Food and Drugs Act to the mineral water business and the distribution of safe and palatable table waters and on the utilization of spring waters at health and pleasure resorts. Papers at another session will take up stream pollution, including the work done by the City of Philadelphia toward the cleaning of the Schuylkill River.

Other meetings include those of divisional officers, Erle M. Billings, of Rochester, New York, presiding, and local section officers, with Dr. G. L. Wendt, of Battelle Memorial Institute, Columbus, Ohio, as chairman.

SCIENTIFIC NOTES AND NEWS

Professor William Morton Wheeler, of Harvard University, has been made an honorary member of the Société Entomologique de France. Dr. L. O. Howard is the only other honorary member among Americans.

The doctorate of laws was conferred at the midyear commencement of the University of Pittsburgh on Dr. Herbert Osborn, research professor of zoology and entomology at the Ohio State University.

Dr. Henry Leffmann, professor of chemistry in the Wagner Free Institute and in the Woman's Medical College of Pennsylvania, has been elected an honorary member of the Franklin Institute of the State of Pennsylvania.

Frederick E. Turneaure, dean of the college of mechanics and engineering of the University of Wisconsin, has been awarded the Henry C. Turner gold medal by the American Concrete Institute "for distinguished service in formulating sound principles of reinforced concrete design." The presentation was made on February 13 at New Orleans.

At the monthly meeting of the American Geographical Society on February 25 the Charles P. Daly gold medal was presented to Nelson Horatio Darton, of the U. S. Geological Survey. The citation read: "His preparation of the topographic base maps of Arizona and New Mexico on the scale of 1:500,000 proclaim him a worthy follower in the great tradition of the surveys 'west of the hundredth meridian.' With great energy and continuity of purpose he has carried forward researches in the physical geography of our western domain from its northern to southern borders and beyond, laying foundations for the fuller enjoyment of its resources."

Dr. Herman A. Spoehr, assistant director in charge of the Coastal Laboratory for botany of the Carnegie Institution of Washington, has been appointed director of the Division of Natural Sciences of the Rockefeller Foundation. He succeeds Dr. Max Mason, recently elected president of the foundation. Dr. Spoehr will take up the work on September 1.

Professor W. Carl Rufus, of the department of astronomy of the University of Michigan, has been named acting director of the department and acting director of the university observatories, to fill the place of the late Professor Ralph H. Curtiss. Dr. Rufus has been connected with the university since 1917.

Dr. Earl D. Bond, who since 1913 has been medical director and physician-in-chief of the department of mental and nervous diseases of the Pennsylvania Hospital, has been appointed professor of psychiatry in the University of Pennsylvania Medical School and will join the faculty on July 1. Dr. Bond also became medical director of the institute for mental hygiene at the Pennsylvania Hospital when the institution opened its new building on March 1.

Dr. Henricus J. Stander, associate professor of obstetrics in the Johns Hopkins Medical School, has been appointed professor of obstetrics and gynecology in Cornell University and head of these departments in the New York Hospital, effective in September, 1931. Dr. Stander will remain at the Johns Hopkins until that time and will act as adviser in obstetrics and gynecology to the New York Hospital in the development of their woman's clinic as part of the plant of the New York Hospital-Cornell Medical College Association.

Dr. Gerald S. Shibley, of Columbia University, has been appointed associate professor of medicine in the school of medicine of Western Reserve University, the appointment to take effect on July 1. Dr. Shibley will occupy a similar position on the staff of Lakeside Hospital.

Dr. George M. Peterson, who has been connected with the staff of the U. S. Treasury Department for the past two years, has been appointed associate professor of agricultural economics on the Giannini Foundation of Agricultural Economics in the University of California.

Dr. Bruce L. Warwick, formerly assistant professor of genetics and veterinary science, University of Wisconsin, has succeeded Dr. J. L. Lush as animal husbandman, breeding investigations, of the range animal husbandry division, Experiment Station, Agricultural and Mechanical College of Texas. Dr. Lush has accepted a position at the Iowa State College.

Charles A. Dobbel, assistant professor of mining and metallurgy at Stanford University, was recently appointed engineering assistant to Dr. Ray Lyman Wilbur, Secretary of the Interior.

H. E. Foote (Ph.D., Brown, '17), a member of the investigational staff of the Mellon Institute since 1927, has been awarded the industrial fellowship on oxygen by the Gas Industries Company, Pittsburgh, designers and builders of liquid-air oxygen apparatus. The investigation is to be concerned with the extension of the present uses of oxygen, and in particular with the application of cheap oxygen in various industrial processes, including metallurgical operations and organic oxidation reactions.

At the annual meeting of the Research Board of the Engineering Foundation on February 20, officers for the ensuing year were elected as follows: *Chairman,* H. Hobart Porter; *vice-chairmen,* Otis E. Hovey and G. H. Clevenger; *additional members of the executive committee,* Gano Dunn, George L. Knight; *director and secretary,* Alfred D. Flinn.

Dr. Wilfred H. Osgood, curator of zoology at Field Museum of Natural History, has gone to London, taking with him a number of specimens obtained by the William V. Kelley-Roosevelts Expedition to Eastern Asia which he will study and compare with type-specimens in the British Museum (Natural History).

An expedition headed by Dr. and Mrs. Herbert Spencer Dickey will leave New York on March 20 in a renewed attempt to discover the exact source of the Orinoco River in South America and possible archeological remains. The expedition is under the auspices of the Museum of the American In Heye Foundation, of which Dr. Dickey is a member.

Dr. Oliver C. Lester, dean of the graduate sc and professor of physics at the University of Co rado, who has visited the laboratories of physics universities in England, Scotland, Germany, Franc Switzerland, Italy and Austria, left Colorado on September 4 and spent some time at the California Institute of Technology and the University of California before sailing for London. Dr. Lester returned to New York on February 15, and will spend the next six weeks visiting laboratories in the eastern part of the United States. He will resume his work at the University of Colorado on March 28.

Professor W. E. Allen, of the Scripps Institution of Oceanography, La Jolla, will cooperate with the United States navy in its research on paint to protect ships against marine growths. He will be present in San Diego each month when conditions of growths are inspected.

Dr. Hugh S. Taylor, professor of chemistry and chairman of the department of chemistry at Princeton University, and Dr. Wallace R. Brode, assist professor of chemistry at the Ohio State Univers will lecture during the intersession of the Univer of California from May 19 to June 28. During thi session Dr. Wolfgang Panzer, professor of geography at the University of Berlin, will give two courses, one on geography and the other on climatology.

At the meeting of the American Geographical Society on February 25, Mr. R. H. Sargent, of the U. S. Geological Survey, delivered an address on "Alaskan Glaciers from the Air." Mr. Sargent exhibited and described a selection of the aerial photographs made by the Navy Department in cooperation with the U. S. Geological Survey as part of the government mapping program in Alaska. Of special interest were a series of slides illustrating features of glacier flow.

Dr. E. W. Berry, professor of paleontology in the Johns Hopkins University, delivered an address on "The Origin and Evolution of Plants" before the Washington Academy of Sciences on February 20. This is the third of a number of lectures proposed by the academy on various phases of genesis and deve opment or "Origin and Evolution," which eventually, and as revised by the authors, may be assembled in book form.

Dr. Albert W. Hull, assistant director of the research laboratory of the General Electric Company, lectured before the Franklin Institute, Philadelphia, on February 19 on "Vacuum Tube Research."

Professor G. W. Stewart, head of the physics rtment at the State University of Iowa and na- l president of Sigma Xi, addressed the Iowa e College Chapter of Sigma Xi at Ames on oruary 17. He spoke on "The Liquid State of atter." The following day Dr. Stewart spoke be- re the graduate school and the physics seminar on Experiments in X-ray Diffraction."

Professor S. R. Williams, of Amherst College, was the guest of the Rosa Club at Wesleyan University on February 25. Following dinner at the Eclectic Fraternity, Professor Williams addressed the club members on "Teaching and Research in the Field of Physics." Other guests included the faculty committee on vocational guidance and all undergraduates who are interested in physics.

On February 15 Dr. H. T. Barnes, professor of physics in McGill University, delivered a lecture before the Royal Canadian Institute on "Winter Waterways of Canada."

Dr. A. Landé, visiting professor from the University of Tübingen at the Ohio State University, gave a lecture at Ohio University, Athens, on February 20 tled "Recent Advances in Atomic Structure."

A symposium upon "Evolution and Human Life" s held by the Philosophical Union of the University of California at Los Angeles on February 28. Papers were presented by Dr. J. Arthur Thomson, of the University of Aberdeen, who will be one of the principal speakers at the formal dedication of the new campus and buildings of the university on March 27 and 28; by Dr. Thomas Hunt Morgan, of the California Institute of Technology, and by Dr. Herbert Wildon Carr, who has been a member of the faculty of the University of London.

The fifteenth annual meeting of the American Association of Petroleum Geologists will be held at New Orleans, Louisiana, from March 20 to 22. The Roosevelt Hotel is headquarters for the convention. Arrangements are in charge of the executive committee composed of the five elected officers of the association, with the cooperation of the New Orleans Convention and Publicity Bureau, Inc., and the management of the Roosevelt Hotel. Nearly a hundred papers are being offered for the program, so that concurrent sessions will be necessary, the several different phases of geological science as applied to the petroleum industry being separated for special sessions in separate rooms. The membership now numbers 2,300. Geophysicists and paleontologists will also have special programs at this convention, the latter group being organized as an affiliated society of the American Association of Petroleum Geologists and known as the Society of Economic Paleontologists and Mineralogists, of which the officers are: *President*, Marcus A. Hanna, Houston, Texas; *Vice-president*, John B. Reeside, Jr., Washington, D. C.; *Past-president*, R. C. Moore, Lawrence, Kansas; *Secretary-Treasurer*, F. B. Plummer, Austin, Texas, and *Editor*, Joseph A. Cushman, Sharon, Massachusetts.

The laboratory of animal nutrition at Cornell University has recently moved into new quarters provided at the cost of $30,000. Facilities are provided for the study of the fundamental phases of nutrition in both its chemical and physiological aspects. The work of the laboratory is being developed under the direction of Dr. L. A. Maynard and Dr. C. M. McCay.

DISCUSSION

THE ETIOLOGY OF THE DISEASE PSITTACOSIS

The recent outbreak of human disease associated with disease in parrots resembled in its clinical aspects the disease psittacosis. The etiology of this disease has been in doubt, largely because of the failure to find an agent common to all or most of the cases examined and in the associated ill parrots.

Our investigations were started about January 15. We obtained material from a series of cases and in none were we able to find any evidence that infection by the *B. psittacosis* existed. A sick parrot in a family where there were two ill adults was the only nstance where both sources of material were avail-le for laboratory study. The parrot died and an emulsion of the organs fed and injected into another parrot reproduced the same disease picture. The organs of this parrot were emulsified and filtered through a Berkefeld V filter. This when inoculated produced the same disease picture. The materials from this parrot, filtered in the same way, again produced the disease.

The sputum and blood from one of the cases mentioned above were fed to a parrot and a disease picture resulted resembling that of the parrot which presumably infected this case. The organs of the inoculated parrot were used to infect another parrot, after the material had been filtered through a Berkefeld V filter. The disease was again produced. The material from the second parrot, again filtered, caused the disease and death in a third parrot.

These observations indicate that from the original parrot and also from the human contact we obtained a filtrable virus and that this virus is the primary etiological agent of the disease.

This virus will kill mice whether the material be filtered or not. The virulence for mice does not seem very great, as a few mice survive.

There is an inherent source of error in observations of this character, *viz.*, the danger of "picking up" a virus in the experimental animals used. This possibility has been excluded as far as possible by using parrots from sources free of disease and parrots which had been imported sometime before the appearance of the disease.

As this preliminary note was being prepared a short report in the *Lancet*, February 1, 1930, of the work of Bedson, Western and Simpson came to our attention. They, likewise, believe that they have demonstrated a filtrable virus in parrots. They do not report a similar demonstration in the case of human materials.

We also have caused the death of a parrot with emulsions of the organs of a fatal human case, but filtration experiments on this presumed virus are not completed.

Our observations and those of the English investigators seem for the first time to offer definite indications as to the etiology of the disease psittacosis.

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BACTERIUM GRANULOSIS AND TRACHOMA OF AN URBAN WHITE POPULATION

IN a recent issue of SCIENCE[1] a brief note has been published extending the original publication of Noguchi on *Bacterium granulosis* (*nov. spec.*) in relation to the trachoma occurring among the Indians in New Mexico and Arizona. The present report has for its purpose to record the isolation of *Bacterium granulosis* from cases of trachoma occurring in New York City and further experiments on contact infection.

Through the kindness and cooperation of Dr. Martin Cohen, we obtained specimens removed for curative purposes from two patients who had suffered from trachoma two and ten years, respectively. In both patients the pannus and scar-formation, characteristic sequels of the trachomatous disease, were present.

The specimens were employed in the preparation of cultures according to the original Noguchi methods, and from both bacteria were isolated which conformed in all biological properties with *Bacterium granulosis* as obtained from cases of Indian trachoma. Moreover, when the cultures obtained from the New York cases of trachoma were inoculated into monkeys by the Noguchi method, they gave rise in from sev[illegible] thirty-three days to the granular conjunctival c[illegible]tion characteristic of experimental trachoma and [illegible]sembling closely trachoma in man.

Tyler[2] had found that when monkeys in which the experimental granular, trachomatous lesions a[illegible] present and normal monkeys with smooth conjunctivae are caged together, the previously healthy animals acquire the experimental disease. Noguchi had previously observed the extension of the lesions from the inoculated to the uninoculated eyes of *Macacus rhesus* and chimpanzees. This presumable contact infection was shown by Tyler's experiments to be possible between inoculated and uninoculated animals.

We have since found that when the secretions from monkeys with the granular lesions are taken on cotton swabs and transferred directly, by rubbing, to the eyes of normal *Macacus rhesus*, the experimental trachomatous disease is promptly produced. In addition, it has been found that when cultures of *Bacterium granulosis* are instilled into the conjunctival sac of normal monkeys and the eyelids gently massaged, infection also occurs and the granular lesions appear quite as early (thirteen days) as after subconjunctical injection.

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ACCUMULATION OF GAS IN CLOSED COLLODION SACS IMMERSED IN FLOWING TAP WATER

IN SCIENCE for September 20, 1929, there appeared an article by Stacy R. Guild with the title given above. The essential experimental fact reported is that when a closed collodion sac containing water or an aqueous solution is immersed in running water under some circumstances a bubble of air will be slowly formed within the sac, and grow at a rate proportional to its own surface, while at other times a bubble already present will dwindle away. The experiments sugges strongly that the controlling factor is the amount of air dissolved in the water; when this amount is known to be large, the bubble grows, and when the water has been degassed before use, the bubble shrinks. Guild appeals to physical chemists to "determine the laws governing this phenomenon and to work out the true explanation of it."

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[1] E. B. Tilden and J. R. Tyler, SCIENCE, 71: 186, 1930.

[2] J. R. Tyler, SCIENCE, 70: 612, 1929.

We think that the phenomenon is much less obscure than Guild supposes. In fact, his own experi-ts are extensive enough to show that there are no obscure factors operating. It is merely neces-y to suppose that a collodion membrane is perme-e to air. Tap water is commonly saturated with at a pressure greater than atmospheric; that is, ie partial vapor pressure of the dissolved air is reater than one atmosphere. Then if the membrane is permeable to air (*that is*, nitrogen, *oxygen*, etc.) air will pass through until the water on both sides contains air at the same partial pressure. But if this partial pressure is greater than the mechanical pressure on the water, which is, of course, one atmosphere, then the system is unstable, air will be evolved more or less rapidly and a bubble will form. Once the bubble is started, the rate of growth will be proportional to the interface, that is, to the surface of the bubble. When we have the bubble in the sac and flow degassed water past it, the same processes occur in the reverse direction. The water inside the sac is saturated with air at a pressure greater than that outside, so that air is lost to the running water and the bubble shrinks.

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HISTORY OF THE DISCOVERY OF PERIODIC REVERSAL OF HEART-BEAT IN INSECTS

Supplementary Note

In a recent paper[1] I have traced the early history of the discovery of periodic reversal of peristalsis of the heart in Lepidoptera, a phenomenon which accompanies metamorphosis and continues to the end of life, resembling in certain respects a similar phenomenon in ascidians. Periodic reversal in Lepidoptera, discovered by Malpighi in 1669, expressly denied in the first half of the nineteenth century by such excellent observers as Herold (1823) and Verloren (1844), confirmed for the chrysalis (silkworm) by Cornalia (1856), was first adequately described by Bataillon (1893, 1894).

In writing this historical review I was unaware of the second paper on the subject by Bataillon,[2] in which he extended his observations to the adult silkmoth and found, as I have done recently, that periodic reversal in the direction of the heart-beat is not a temporary phenomenon connected with metamorphosis but, in confirmation of Malpighi's observations, is characteristic of the adult moth. I will here briefly summarize and translate Bataillon's later conclusions.

He states that, having regarded the phenomenon as connected with disturbances in nutrition during metamorphosis, he had been skeptical of Malpighi's observations on the adult, especially in view of the fact that they were made on the eviscerated insect under obviously abnormal conditions. Continuing he says:

> If the dorsal integument is carefully shaved and the median line smeared with glycerine to make it more transparent, the heart becomes visible, and its movements can be observed until death. Here, again, in spite of the defects of his technique, Malpighi was right. The circulation takes place sometimes in one direction, sometimes in the other.

On the basis of experiments upon full-grown larvae, he concluded that pupation and periodic reversal of circulation in the dorsal vessel depend upon three factors which presumably reduce internal pressure, *viz.*, elimination of the contents of the intestine, transpiration and spinning.

Of the adult insect he says:

> There are, at first, successive periods of direct or of reversed circulation every one or two minutes; then these periods are longer, especially while the individuals are in copulation. Finally, the contractions of the dorsal vessel succeed each other regularly and alternately, from in front backward and from behind forward, becoming less and less marked at the approach of immobility and death.

Thus he calls attention to the comparatively short periods of forward and backward peristalsis in the young moth, to the longer phases sometimes induced by copulation and to the reduction of the successive alternating phases in old age to single beats, observations similar to those which I have made.[3]

Hypodermic injection of saline solution (seawater) into the blood of the adult moth caused an immediate cessation of reversal; forward beating alone occurred for several hours. The employment of suction, on the other hand, was followed by long periods of backward beating. By the injection of air into the hemolymph, the forward flow of the blood was enormously stimulated and became even tumultuous; this was seen in marked degree in old individuals which were decrepit and motionless. Such a moth, for example, injected in the morning, immediately was thrown into a state of intense activity which continued during the rest of the day, followed by death a few hours later.

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[1] J. H. Gerould, *Biol. Bull.*, 56 (3): 215–225, 1929.

[2] E. Bataillon, "Nouvelles recherches sur les méchanismes de l'évolution chez le Bombyx mori," *Revue bourguignonne de l'enseignement supérieur*, 4: 1–16, 1894.

[3] J. H. Gerould, "Periodic Reversal of Heart Action in the Silkworm Moth and Pupa," *Jour. Morph. and Physiol.*, 48: 385–430, 1929.

In conclusion Bataillon says:

> The entire life of *Bombyx* from the spinning to death presents constant physiological characteristics: lowering of internal pressure; respiratory and circulatory disturbances, and histolysis. . . . The circulatory disturbances . . . are merely the permanent index of more profound disruptive changes.

Both Bataillon in his earlier paper (1893)[4] and Fischer (1918)[5] suggested that periodic reversal may be due to increased acidity of the blood accompanying metamorphosis. This idea is supported by a recent paper in Japanese by Yokoyama[6] who has succeeded in bringing about periodic reversal prematurely in the larva by blocking the abdominal spiracles with enamel paint or by injecting into the hemolymph of the abdomen (at the eighth abdominal segment) weak solutions of lactic or acetic acid.

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THE CHEMICAL CONSTITUTION OF PECTINATELLA

IN searching for material in order to study the synthesis of protein, Pectinatella was examined. The thought was that here was a source of rapidly formed gelatin, or its precursor collagen. A mass weighing from 2 to 5 kilos is formed within a few weeks, comparable to the growth of certain tumors. The fact that investigation reveals that the jelly-like secretion is not of the nature of collagen but of true protein of a fairly high order does not rob the study of its interest or importance, for the organism stands as a readily available source of study of extremely rapi synthesis of protein.

The material was supplied by Professor Raymond C. Osburn, director of the Stone Laboratory, Put-in-Bay, Ohio. Pectinatella is available in large quantities during the summer and autumn. It may be preserved in fresh water, and sampling is possible from the growth, the remainder proceeding with its growth without detriment.

The water content is high. A specimen weighing 1,200 grams gave, on drying, 5.0 grams dry weight. Protein, etc., therefore make up about 0.5 per cent. of the normal body.

The protein reactions were typical of such proteins as ovalbumin, serum albumin, etc. The biuret reaction was positive and typical, that is, like that of white of egg and not like that of gelatin or peptone.

The following amino-acids were demonstrated tyrosin, tryptophane, cystin. In a cold extract o the dried material all three were positive, but th reactions were intensified after acid hydrolysis. Thi was especially true of cystin. The protein was heat coagulable.

Of the inorganic substances, sodium chloride was demonstrable. Phosphorus was negative before hydrolysis, and after boiling with equal volumes of sulphuric and nitric acids, none was demonstrable. Calcium is present in copious amounts, as one would suspect from the calcareous nature of the body and statoblasts.

Characteristic of these organisms is the supporting structure composed of chitin. In the specimens examined chemically, glucosamine (galactosami was readily demonstrable after hydrolysis. amino-sugar has extensive distribution through animal kingdom and in man occurs in cartilage.

WITHROW MORSE

JEFFERSON MEDICAL COLLEGE,
JANUARY 3, 1930

REPORTS

THE TEACHING OF HYDROBIOLOGY AND AQUICULTURE IN AMERICAN UNIVERSITIES

THE committee on aquiculture of the Division of Biology of the National Research Council has had a subcommittee engaged in gathering data on the teaching of hydrobiology and aquiculture in American universities. This committee has consisted of James G. Needham, A. G. Huntsman, Chancey Juday and E. N. Transeau. A report has recently been submitted, embodying the following data.

Sixteen institutions in the United States and Canada give courses in these subjects. These institutions and their undergraduate courses are listed in the accompanying table. These courses are called by various names, as indicated in the footnotes to the tab

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[4] E. Bataillon, *Bull. Sci. France et Belgique*, 25: 18–55, 1893.

[5] E. Fischer, "Eine bei Raupen und Puppen beobachtete Umkehrung der peristaltischen Herzbewegung," *Entom. Rundschau. Stuttgart*, 35: 9–10, 1918.

[6] T. Yokoyama, "Notes on the Periodic Reversal of Heart-beat in the Silkworm *Bombyx mori* L.," *Dobutsugaku Zachi* (*Zool. Mag.*), 39, No. 459, Suppl.: 45–51, 1927.

SUMMARY OF INSTRUCTION IN HYDROBIOLOGY AND AQUICULTURE IN NORTH AMERICAN UNIVERSITIES, 1929

Institution	Staff	Limn.*	Aqc.**	Ichthyology	Dis.***
1. Cornell	P P P I	3	3	6	
2. Illinois	P P P	3			v
3. Indiana	P I	5 +			
4. Iowa	P				
5. Kansas	P	3			
6. Maryland	P	v		v	
7. Michigan	P P P P I	5 + 4‡		2‡	4 +
8. Montana	P	†			
9. N. Carolina	P	5			
10. Queens	P	4	4		
11. Rutgers	P P P P	3			3
12. Stanford	P P P	3†			
13. Toronto	P P	3			
14. W. Virginia	P P	2†			v
15. Washington	P P P P I	5 + 5	5 - 5	5	5
16. Wisconsin	L	2 + 2			

Under Staff, P = professor, I = instructor, L = lecturer, conducting the course listed. In other columns, numerals indicate credit hours in courses; v = variable.

* Limnology or hydrobiology or fresh-water biology.

** Aquiculture or fish culture.

*** Diseases of fishes or fish parasites.

† Limnology directed toward public health rather than toward aquiculture.

‡ Repeated in summer at the biological field station of the university.

[illegible]ing to the newness of the subject of instruction [illegible] are very diverse also in content and in emphasis. [illegible] great is this diversity that a blank designed to gather data proved to be of little use. It merely developed these facts not shown in the table:

1. That these are upperclass courses.

2. That from one to three courses in zoology are the usual prerequisites; less often, courses in botany, ecology and entomology.

3. That the study of plankton and systematic determinations of invertebrate animals still receive chief emphasis.

4. That a little quantitative work is done in very different subjects.

5. That a rather high proportion of field work during the portion of the year favorable to it is the rule.

6. That emphasis on marine biology goes with proximity to the sea.

Our table seems to show a considerable staff of men engaged in teaching the subjects listed, but as a matter of fact nearly all these men do this work incidentally to other heavier duties. They do it voluntarily in addition to the other teaching or administrative work that is required of them. Aside from the staff of College of Fisheries of the University of Washington (where the emphasis is on marine biology) there appear to be but three men commissioned to devote themselves wholly to fresh-water work: Dr. Juday to limnology at Wisconsin, Dr. Embody to aquiculture at Cornell and Mr. W. J. K. Harkness at Toronto. Dr. Embody's course in aquiculture has been running since 1912.

Courses in ichthyology and parasitology are included in this table only for those institutions that offer also the other subjects; they are here included because they are important contributory training for hydrobiology. There are courses in all universities that provide training in the fundamental sciences.

There are other bits of related work omitted, such as the plankton work that is done at the University of Colorado in a course on bacteriology for civil engineers, and parts of courses in ecology, zoology, parasitology and microbiology given in a number of institutions, notably in Illinois, Ohio and Toronto.

The two Canadian institutions listed have representatives on the Biological Board of Canada and participate in its summer field work. The department of biology of the University of Toronto provides certain offices for the board and maintains a special laboratory for fresh-water investigation, the Ontario Fisheries Research Laboratory.

JAMES G. NEEDHAM, *Chairman*

CORNELL UNIVERSITY

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A MICROCINEMATOGRAPHIC APPARATUS FOR THE OWNER OF A 16-MM MOTION PICTURE CAMERA

THE usefulness of motion pictures for teaching and demonstration of scientific facts has been established long ago; this is especially true in the microscopic field, where phenomena are to be demonstrated before an audience. A microscopic demonstration becomes impractical when the audience is of any size.

It is therefore a great satisfaction to have the experiment "stowed away" in the form of a motion picture film to be ready for projection whenever and wherever needed.

To make motion picture records of microscopic objects, if one has the necessary microcinema equipment, is not difficult at all. An apparatus designed for this purpose has been described in SCIENCE[1] and in the *Transactions* of the Society of Motion Picture Engineers.[2] It is a standard equipment for modern laboratories doing microscopical investigations. This apparatus, however, requires the use of standard motion picture film of 35 mm width (professional size).

In order to enable the owner of a 16-mm motion picture camera (amateur size) to make microscopic film records without difficulties and great expense, an apparatus (Figs. 1 and 2) has been devised whereby any 16-mm camera, be it either Filmo, Ciné Kodak, Victor Ciné Camera, etc., can be used. The apparatus is constructed upon the same principles as the large machine although more simplified and smaller in size, the actual dimensions being 22 x 14 x 9 inches.

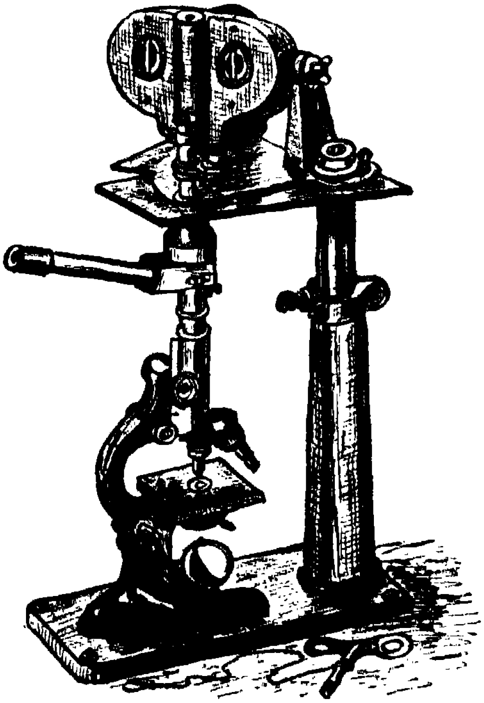

FIG. 1. Microcinema Apparatus with Filmo 70 (Bell and Howell Company), driven by spring motor, adjustable speed up to 128 exposures per second.

The instrument consists of a cast-iron base plate with sleeve, a steel column, a fixed and a swivel plate with focusing and beam centering device. All parts are machined, turned and polished and assembled with great care and precision, so that serious work can be done with it.

The microscope, of any make, is placed on the base plate and brought in line with the focusing device. When the object is sharply in focus it is also automatically in focus on the film in the camera, and the film record can be taken immediately by swinging the camera into position over the microscope and releasing the spring motor or turning the crank of the camera.

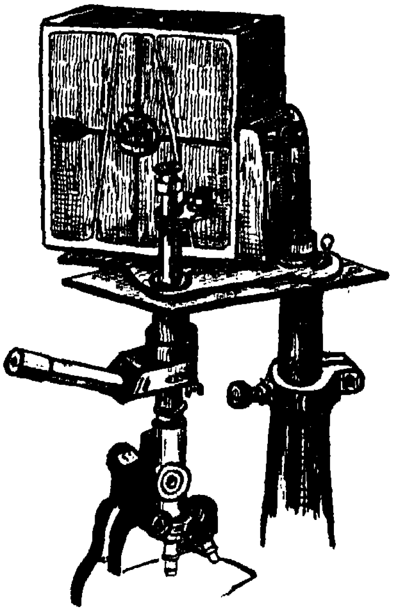

FIG. 2. Microcinema Apparatus with Ciné Kodak Model A, hand driven. Attachments are available for "slow motion" and "time lapse."

A beam splitter with observation tube can be employed when it is desired to observe the specimen while it is being photographed.

As a light source any projection lamp fro to 200 watt is more than sufficient when ordi bright field pictures are to be taken. For taking tures with dark field illumination (indirect illumi tion) a small arc lamp of the ordinary type (abou 4, 5 ampere) is recommended.

Pictures of small objects, for instance, insects, et may be easily taken, by removing the microscope an using a small lens attachment which can be screwed onto the fixed plate.

Another attachment can be substituted whereby single exposures at certain predetermined time intervals can be made. This device consists of an electric timer which controls the camera and also the light source. This arrangement is for the purpose of making accelerated motion pictures for the study of slowly moving objects, for instance, living tissue cells the growth of bacteria, etc.

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[1] 69: 672, June 28, 1929.

[2] 18: 461–464, 1929.

SPECIAL ARTICLES

"AUXIMONES" AND THE STIMULATION OF LEMNA BY ORGANIC MATTER

Some time after the discovery that vitamins were necessary for the growth and well-being of animals, a claim was put forward by Bottomley and Mockeridge that similar substances were essential for the growth of green plants. These investigators found Lemna (duckweed) failed to grow and repro- continuously in two well-known salt solutions, that if extracts of organic matter from peat, soil manure were added, satisfactory results were obtained. From their experiments they concluded

> It is now established that plants, in their turn, require growth-promoting substances, or auximones; which in the case of the lower plants, are apparently manufactured by themselves, but which in the case of green plants, must be supplied from without. Since these necessary accessory substances are essentially organic in nature, their only possible source in the case of ordinary green plants is to be found in the organic matter of the soil in which they are growing.[1]

My attention was drawn to the work of Bottomley when I was studying the reproduction of yeast in synthetic media at Toronto. I found that it was possible to grow yeast without the addition of any organic matter except sugar, although reproduction was always better when particular organic extracts were added. Fulmer, however, proved conclusively that these "Bios"-containing extracts were stimulants and not essentials. It occurred to me that similar results might be obtained with green plants if they grown in suitable inorganic solutions.

Some time later at Iowa State College I had the opportunity of going more fully into the auximone theory. It was necessary first to find an inorganic medium in which the Lemna would reproduce without the addition of organic matter. To this end Mr. Roller and I set out systematically to test salt solutions containing the essential elements; eventually we obtained an inorganic medium in which Lemna major reproduced and remained healthy without any added organic matter.[2] This showed that there are no *essential* organic substances needed for the green plant in the same way that vitamins are necessary for animals. I investigated shortly afterwards the pH required by the plants and the effects of duration and intensity of light.[3] In all cases the medium was made from carefully purified salts and special care was taken to have distilled water free from contamination. Recently Ashby, in London, has used this medium for the growth of Lemna minor and has confirmed our conclusions.[4]

These results, however, still left open the question of stimulation of green plants by organic matter. Mockeridge found stimulation with soil and manure extracts, even with an inorganic medium unsuited to the Lemna—the greater the degree of decomposition of the manure, the more stimulation was found. The theory was therefore put forward by Mockeridge that bacteria produce the substances which stimulate the plant: "The work of elaborating the growth-promoting substances is therefore thus relegated to the soil bacteria."[5]

We have found that extracts of manure, of soil and of alfalfa, as well as various "Bios" fractions which affect the growth of yeast, will increase the rate of reproduction of the Lemna when the pH is kept constant. There is a rapid rise in the rate, from less than one part per million of the organic matter in the solution, up to ten parts per million for the particular soil used, twenty for the manure and sixty for the alfalfa, although the alfalfa extract did not behave exactly like the soil and manure extracts. There is a maximum rate of growth over a considerable range, after which the addition of more extract makes the medium increasingly toxic, especially with the alfalfa. Ashby has found that stimulation occurred with 0.2 parts per million of organic matter extracted from horse dung, that it was not impaired by autoclaving and that the ash did not increase the growth rate.[6] He considers that the action of the organic matter is catalytic in nature, "since any addition above a minimum dose has no further effect upon the growth rate."

In these experiments great care was taken to keep the plants as free as possible from contamination with micro-organisms. Ashby, in his later experiments, sterilized his solution and changed it every forty-eight hours—in some of my experiments I changed every twelve hours.[3] It seemed to me, however, that there was always the possibility of a symbiotic relationship between the Lemna and bacteria in which the latter would make use of the organic matter. In order to do away with this possibility it was necessary not only to grow the plants in a sterile solution, but also to free them entirely from bacteria—a much more difficult operation. It was to this problem that Mr. Roller turned his attention last winter.

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[1] Mockeridge, *Biochem. Jour.*, 14: 432, 1920.

[2] Clark and Roller, *Soil Sci.*, 17: 193, 1924.

[3] Clark, *Jour. Phys. Chem.*, 29: 935, 1925; *Plant Physiol.*, 1: 273, 1926.

[4] Ashby *et al.*, *Ann. Bot.*, 42: 771, 1928.

[5] Mockeridge, *Ann. Bot.*, 38: 723, 1924.

[6] Ashby, *Ann. Bot.*, 43: 805, 1929.

Hansteen in 1898 had reported an attempt to sterilize Lemna by washing—testing for bacteria by the effect on egg albumen. We were quite unable to free the plants of bacteria by this method—whatever the effect on the albumen, some bacteria always grew on a nutrient agar. This would be expected, and we found in later experiments that plants which were bacteria free on the surface—no growth showing for five or six days on agar—when macerated, produced colonies abundantly.

In his sterilization experiments Mr. Roller tried ultra-violet light and a large number of antiseptics at various concentrations, and finally developed a technique which killed the micro-organisms both inside and outside the plant—no growth is developed on any medium yet tried for the bacteria whether the plant is macerated or not. We have grown the sterile Lemna through some twenty-five to fifty generations in the inorganic solution and they are reproducing normally and continue to look healthy. The first unexpected result was that the rate of reproduction of the sterile plants was greater than that of the non-sterile plants in the sterilized inorganic medium.

A second unexpected result was that the addition of sterile organic extracts of soil and manure (optimum concentrations) to the sterile inorganic medium with the sterile plants resulted in a decreased rate of reproduction compared with the sterile checks in the purely inorganic medium; the non-sterile plants, with the same sterile additions of organic matter, reproduced faster than the non-sterile plants in the sterilized inorganic solution—a confirmation of the work we have mentioned above, and as Ashby has also reported. Without bacteria the organic matter seems to depress the rate of reproduction, although we have not yet found whether this is due to a variation in the optimum concentration of the organic matter under the sterile conditions.

At the same time cultures were run in which the sterile plants had added to them, both in the sterilized inorganic solution and in the sterilized solution with organic extracts, an infusion of live bacteria from soil. The inorganic solution with the bacteria tended to decrease the rate of reproduction of the Lemna; where the organic matter was present the rate was greater than in the same solution without the bacteria, but it did not altogether overcome the original depression caused by the organic matter—the rate was distinctly lower than the checks for the sterile plants in the sterile inorganic medium.

In the sterile medium with sterile plants we have so far failed to get stimulation of the rate of reproduction of the Lemna by adding sterile organic extracts which certainly increase the rate when the plants are non-sterile. Details of this work with the effects on dry weight and ash will be reported later after some of the debatable points are examined further, but the present state of the problem is distinctly interesting.

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OCCURRENCE OF GERMANIUM AND ARSENIC IN METEORITES[1]

THE only record of a non-terrestrial occurrence of germanium is due to Rowland[2] who obtained spectroscopic evidence of this element in the reversing layer of the sun. Investigations carried on in this laboratory established the fact that germanium is of wide distribution in so far as the earth's crust is concerned.[3] On deciding to extend these investigations to meteorites, six specimens were selected representing siderites, siderolites and aerolites. The specimens were subjected to arc spectral excitation by a method described elsewhere,[4] and the spectrograms were examined in the range between λλ 3040 and 2530 angstroms. In all cases the germanium lines λλ 2651.6 and 2651.1 were definitely, though faintly, visible. These lines are extremely helpful in recognizing germanium: in addition to their being highly persistent they lie in a range where the dispersion of the prism spectrograph is considerable, thus minimizing difficulties due to overlapping of lines, especially when specimens of complex composition are examined.

On the basis of these observations it is to be concluded that traces of germanium are present in the following meteorites:

1. Siderite from Toluca, Mexico.
2. Siderite from Welland, Ontario. (Fell 6: 30 A. M., December 14, 1807.)
3. Siderolite from Admire, Lyon County, Kansas.
4. Siderolite from Llano del Inca, Atacama, Chile. (Found in 1888.)

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[1] Presented at the forty-third meeting of the American Astronomical Society, Harvard College Observatory, January 1, 1930. The investigation upon which this announcement is based was supported by a grant to S. L. Boothroyd and Jacob Papish from the Heckscher Foundation for the Advancement of Research, established by August Heckscher at Cornell University.

[2] Rowland, *Amer. Jour. Sci.*, 41: 243, 1891.

[3] See Papish, *Econ. Geol.*, 23: 660, 1928; 24: 470, 1929. Additional work is ready for publication.

[4] See Papish, Brewer and Holt, *Jour. Amer. Chem. Soc.*, 49: 3028, 1927.

5. Aerolite from Estacado, Crosby County, Texas.

6. Aerolite from Allagan, Allagan County, Michigan. (Fell July 10, 1899.)

The two siderites, of which the writers possessed a comparatively large quantity, were subjected to chemical treatment for the purpose of extracting germanium from them. The procedure was as follows.

Twenty-six grams of the Toluca siderite and sixteen grams of the Welland siderite were introduced into separate Pyrex distilling flasks connected to water-cooled condensers and provided with glass receivers cooled with ice. An excess of hydrochloric acid was added to the meteorites through dropping funnels. The reaction, which was violent, was allowed to proceed to completion. The solutions in the flasks were kept boiling till each was reduced to about one half of its initial volume. In this manner the germanium in the soluble portion was afforded an opportunity to form the tetrachloride, which is a fuming liquid boiling at 86° C., and as such to condense in the cooled receiver together with a preponderating amount of hydrochloric acid. The distillates were next saturated with hydrogen sulphide and allowed to stand several days. The precipitated sulphides were collected on small filter papers; the papers and contents were placed in porcelain crucibles and treated with nitric acid. The excess of acid was driven off with the aid of heat, and the viscous residues were examined spectrographically for the presence of germanium. The results were gratifying. The residue obtained from the Toluca meteorite yielded a spectrum which contained the following germanium lines: λλ 3039.1, 2754.6, 2709.6, 2691.3, 2651.6, 2651.1, 2644.2, 2592.5 and 2533. The more persistent of these lines, namely, λλ 3039.1, 2651.6 and 2651.1, were also visible in the spectrum of the Welland meteorite, though their intensity was much lower. This decrease in number and intensity of the spectral lines is to be ascribed to the fact that the quantity of germanium extracted from the Welland meteorite was smaller than that extracted from the Toluca meteorite.

The controversial views expressed by Merrill[5] regarding the presence of arsenic in meteorites made it desirable to look for this element in the two siderites. When the siderites were dissolved in hydrochloric acid and the solutions distilled for the extraction of germanium, it was anticipated that arsenic, if present, would also distil over, as the trichloride. Accordingly, when the distillates were saturated with hydrogen sulphide and the resulting precipitates oxidized with nitric acid, the excess of acid, as already stated, was driven off till *viscous* residues were obtained. It was feared that if the residues were taken down to dryness, or ignited, the arsenic, if present, would be expelled. The spectrograms of these residues contained the arsenic line λ 2780.2. An additional spectrographic examination in the more refrangible range revealed the presence of the following lines also due to arsenic: λλ 2349.8 and 2288.1.

To obviate errors that might result from use of reagents and apparatus, "blank" tests were made as follows. A volume of hydrochloric acid equal to that used in connection with the siderites but somewhat more dilute was distilled in a manner similar to that already described. As a matter of fact, in one case the apparatus employed for this purpose was the same that was used in the work on the Toluca siderite. The distillate was saturated with hydrogen sulphide. As usual a slight opalescence, undoubtedly due to precipitated sulphur, made its appearance. Since there was not enough of this precipitate to be retained by a filter paper, a few milligrams of copper sulphate dissolved in a minute quantity of water were added. The copper sulphate was found on previous examinations to be free from germanium and arsenic, at least in quantities detectable spectroscopically. The precipitated copper sulphide is an ideal adsorbent for traces of other sulphides. The solid material thus obtained was removed by filtration, oxidized with nitric acid as before and examined spectrographically. No lines of germanium or arsenic were observed.

SUMMARY

1. Spectroscopic evidence has been obtained of the occurrence of germanium in certain siderites, siderolites and aerolites.

2. Judging from the number and intensity of spectral lines the germanium in these meteorites is present in traces.

3. Germanium has been extracted from Toluca and Welland siderites.

4. Arsenic has been extracted from Toluca and Welland siderites.

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[5] Merrill, *Memoirs Nat. Acad. Sci.*, Vol. 14, 1st Memoir, p. 8, 1925.

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SCIENCE AND LIFE[1]

By Professor GRAHAM LUSK

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THE explorers of the heavens tell us they have located a galaxy of stars, the light of which, transmitted at the rate of 186,000 miles a second, has been traveling through space for a period of 140 million years before becoming visible to the eye. We may perhaps be pardoned if we take account of the position of some other things which are a little nearer to us. For example, the position of metabolism research has ately been defined by a friend of mine who told me hat it was now so far advanced in this country that needed no further support. It seemed to me to be egrettable that such opinions could be held anywhere. I mentioned this statement to my friend, Karl Thomas, of Leipzig, a former pupil of Rubner, and he comforted me by saying, "Why, the whole of life is metabolism."

A celebrated clinician once elaborated and published a wonderful interlocking endocrinological scheme regarding diabetes. About one out of four of his guesses was right; the other three are now in the receptacle devoted to scientific rubbish. And we witness year after year false interpretations of physical phenomena, because a younger generation has arisen which does not know and apparently does not care to know what the old masters knew of the phenomena of metabolism. It is too much trouble to learn about it. The younger generation wishes to do a few metabolism experiments of its own and to draw conclusions without any knowledge of the background of accumulated evidence which may render the conclusions invalid.

Rubner, during the war, lamented the clamor of those Germans who demanded the production of a super-bread, for he knew of work done fifty years before, which even educated physicians had forgotten, which precluded the possibility of producing a super-bread.

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[1] Delivered before the Piersol Anatomical Society, the University of Pennsylvania, Philadelphia, February 28, 1930.

I would like to dwell for a short time upon the life of Liebig,[2] whose activities were largely responsible for the development of modern metabolism research, as founded in large measure by his pupil, Carl Voit. For the lessons of Liebig's life seem likely to be forgotten in the standardization and mechanized control exercised over American education to-day. So if you will bear with me, we will look backward a hundred years and more.

In 1803 Liebig was born in Darmstadt. He was one of seven children. His father sold oils, paints and dyes. When he was fourteen years old his school teacher complained of his inattention and asked what he would ever become. Liebig replied that he would become a chemist. The laughter which followed this remark caused him to leave school. He sought apprenticeship to an apothecary in the neighboring town of Heppenheim. He learned all he could learn in that environment in ten months and, on returning home, indicated to his father improvements which he could make in his business. At the age of seventeen he went to the University of Bonn to be under Kastner, then the most celebrated chemist in Germany, and he followed Kastner to Erlangen when the latter moved thither.

In a letter written to his parents from Bonn he says:

> I take great pleasure in my studies. The more I understand, the greater my satisfaction. I have begun to realize how little I know, and how much I must learn before I can say, I know something. Please do not forget to send me money.

His typical father writes him from Darmstadt, "Give thyself trouble to learn thoroughly, and practice diligently Latin and French."

And the typical son again, "The most necessary Christmas present which you, my dear parents, can give me, what can it be other than money."

Kastner proved inadequate for the aspiring young student. Liebig has told how Kastner related to the class that the moon had an effect on the clouds, because the moon became visible when the clouds dissolved. But Kastner had the wisdom to recommend this brilliant young man to the Grand Duke of Hesse-Darmstadt and to advise that money be provided so that he could study in Paris. We would to-day call this a traveling fellowship. Through the finance minister, Schleiermacher, Liebig was given a modest sum for his expenses. He traveled to Paris by stage coach at the age of nineteen. At first the small-town lad has a confused impression of the delirious life of a great city, but he writes to Schleiermacher:

> In no other country do the sciences develop so wonderfully as here and this is because of the highly developed mathematical sense of the French scientists, which causes them to reject all useless hypotheses. Gay-Lussac handles the subject of chemistry in a way which shows his complete mastery of it, and Thénard does the same. Experiments are made with lavish expenditure of material. The government spends money freely for such purposes.

Both Thénard and Gay-Lussac had been pupils of Berthollet, who was a pupil of Lavoisier.

Writing more intimately to Walloth, a friend of his own age, he says:

> Behold in me a salutary metamorphosis! The lectures of Gay-Lussac and Thénard have transformed science from an old nag that one has only to saddle in order to ride into a horse with wings which is always trying to escape and which I am constantly trying to capture. I thought I worked in Darmstadt, but here my daily song extends from seven in the morning until midnight and I have pleasure in it. Paris is now much more agreeable to me. Days pass like hours at home . . . and I look sorrowfully forward to the time when I must leave it.

A little later, in a letter to his parents he tells how he has made an interesting discovery. An acid arises from the action of nitric acid on alcohol, and this acid unites with metal oxides to form the fulminates of mercury and of silver. He discovers similar salts of copper, iron and zinc which indicate the exact composition of the substance. The French have been puzzled by these things for a long time. His thesis has been written, Thénard and he review it together and then they walk to the Académie des Sciences. Since Thénard is president of the Académie, he is unable to read the paper, so Gay-Lussac reads it. Liebig brings with him the newly prepared salts and presents them before the Académie. In spite of the rather long thesis there are interruptions of applause. Gay-Lussac and Dulong append their signatures to the following memorandum incorporated in the minutes of the Académie: "Because of the new experiments described in this very remarkable piece of work, we entertain the highest hopes concerning the talents of the author."

After the reading Alexander von Humboldt, the celebrated traveler, who has just returned from Italy after long absence from Paris, a man about fifty-five years of age, approaches the young man and, without revealing his identity, talks with him for nearly an hour and then invites him to dine with him at a restaurant in the Palais Royal, where he tells him who he is.

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[2] The author is especially indebted to his friend, Dr. Margaret B. Wilson, for the source of material contained in "Briefe von Justus Liebig nach neuen Funden," 1928, sold at the Liebig Museum at Giessen; and to Pettenkofer's well-known "Gedächtnissrede des Dr. Justus Freiherr von Liebig" (M. von Pettenkofer, "Populäre Vorträge," Braunschweig, 1876, No. III) delivered in 1874, a few months after Liebig's death.

The outcome of this adventure is that Alexander von Humboldt persuades Gay-Lussac to take Liebig into his laboratory where he can receive direct instruction from the greatest of living chemists. At that time Gay-Lussac refused to receive young men. But Humboldt knew from personal experience what it meant to work with Gay-Lussac; they had analyzed atmospheric air together in 1804. Liebig related to Pettenkofer that when Gay-Lussac and he discovered an especially beautiful fact or accomplished successfully an especially difficult analysis, they danced around a table together, the boy of twenty and the older boy of forty-five.

While residing in Paris Liebig received his doctorate degree in 1822 from the University of Erlangen because of two years of work under Kastner. The thesis was on the subject of the fulminate of silver. In it the errors of others were exposed and his own views were clearly expressed in a style of which he was to become a master.

At the close of Liebig's period of education in Paris, Alexander von Humboldt wrote concerning him to Liebig's patron, the Grand Duke Ludwig, as follows:

> We are fortunate in having with us in Paris one of your subjects, whose superior talents, whose vast knowledge of chemistry and whose sagacity of spirit have attracted the lively interest of the Institute of France. Dr. Liebig unites these qualities with gentleness of character and grace of manner, most unusual among scientists of his age. If my feeble voice carries any weight with your Royal Highness, I beg you to continue your special protection of Monsieur Liebig. He will become a professor who will honor our country, and I am positive that profound gratitude, which will also be shared by my colleagues in the Academy, Gay-Lussac, Thénard, Dulong and Vauquelin, will be extended toward a sovereign who will deign to honor one so especially talented.

Through the influence of this letter Liebig, at the age of twenty-one, was appointed professor of chemistry at the University of Giessen without consultation with any members of the faculty. His laboratory was first established in an old military barracks. It is needless to say that the young professor received very little support from his colleagues.

Writing to Schleiermacher to thank him for a small contribution from state funds toward fitting up living quarters above his laboratory, he says:

> The desire always to retain your regard and good-will prevented me from doing many things in Paris which would now disturb my peace of mind, and was a constant stimulus to try to understand and to investigate the branch of science which I had chosen as a calling. Besides this I have you to thank for the opportunity, on account of which I am fortunately able to make the knowledge then acquired live, and to make it useful for the Vaterland. I have to-day received renewed proof of your truly fatherly benevolence. . . . It makes me sad to think that I have not the skill to express my thanks otherwise than in words. Do not disdain these thanks which come from an agitated and honest heart. It will always be my earnest endeavor to preserve your satisfaction with me.

Liebig had a clear idea in mind, that he would personally instruct other young men in chemistry after the manner that Gay-Lussac had instructed him. He first gave his pupils ideas to work out, and then, when they could think for themselves, stimulated them to do so.

German biographers state that before Liebig the German professors generally adopted the attitude that they were not to unbend to the students and tell them their best thoughts. This was along the lines of Goethe when Mephistopheles says to Faust:

> Das Beste, was du wissen kannst,
> Darfst du den Buben doch nicht sagen.

Liebig reversed this and said, "All that I can do I will make the pupils learn also."

Students flocked to Giessen from Germany and then from all parts of the world, as many as twenty at a time being received. All the dialects of Germany and all foreign tongues were to be heard in the laboratory. Each student felt that he was living a life lofty in purpose, that he was serving science, that he was a pupil of Liebig!

The first part of Liebig's program was the establishment of accurate methods of analysis of organic compounds, methods in vogue to-day after a hundred years. He discovered the dibasic organic acids; he discovered chloral and named it; he made aldehyde from alcohol. He called it "aldehyde" because it was alcohol dehydrogenated. The name created laughter. He could have called it Gay-Lussacin without disturbing the then existing scientific world (Pettenkofer). Liebig, with his devoted friend Wöhler, discovered that benzol was just as constant in many different chemical compounds as arsenic was in the inorganic world. Berzelius was so happy over this that he suggested the name *Proin* for the new radical after a Greek word meaning "the dawn of day." Leibig's publications numbered two hundred on the most varied subjects. Their exceptional quality make the number astounding (Pettenkofer).

Liebig, who had been creating the science of organic chemistry, of which he was the supreme exponent, published in 1840 a volume entitled "Organic Chemistry, Its Application to Plant Physiology and to Agriculture," and then in 1842 appeared his celebrated "Animal Chemistry, or Organic Chemistry Applied to Physiology and Pathology." The wide sweep of his intellectual attainments led the way into such different fields as modern biological chemistry and the modern dye industry.

To read our daily newspapers one might conclude that the dye industry created organic chemistry. To believe that would lead to the conclusion that the steel industry created inorganic chemistry. Liebig himself has pointed out that such conceptions belong to the uneducated mind of the masses and that placing dyes on wool does not belong in the same category as the mastery of chemical research.

The growing world influence of Liebig stimulated one Samuel W. Johnson, the son of a Connecticut farmer. Young Johnson wrote his father in 1849:

> When I behold myself outstripped by others simply because they have the means, I am strongly tempted to repine at the partiality of fortune, but when I read of the achievements of Davy, Faraday, Klaproth, Liebig, Berzelius and a host of others who have elevated themselves from poverty to the highest stations and shed a halo of glory upon their own names and the age that has produced them by their zealous self-denying struggles after truth, how am I encouraged to tread cheerfully the path of science, though alone and exposed to the sneers of the vulgar and the ignorant. . . . Affectionately the same old sixpence, S. W. JOHNSON.

Johnson was then nineteen years old and was teaching school at Flushing, Long Island. Finally, after five years of testing the son, the father gave him in cash the equivalent of what he had given his other children in farm lands, animals, houses and barns. Thus Johnson was enabled to go abroad when he was twenty-three years old, to study with Liebig and to bring home with him those ideas which established first the Connecticut Agricultural Station and later its counterparts throughout the Union.

It is curious to record that in 1849, the same year that Johnson wrote so appealingly to his father, Liebig wrote that if the revolutionary tendencies of the time brought a blood bath at Giessen, they would go to America and found a German university there. These were the days which drove Carl Schurz and Abraham Jacobi to the United States.

Liebig believed with Lessing that talent consisted essentially of work and will power. The industry within his laboratory was prodigious. Liebig was a rare example of one who knew from boyhood what he wished to do. Addressing Thénard in 1841, he says he had had no other introduction to him in Paris except his love of study and his fixed desire to profit by his teachings. His associate, Pettenkofer, says that Liebig's power lay in the nature of his being, in attributes which no man can acquire but which are inborn. He had endurance, diligence and good methods. He had a sharp penetrating understanding coupled with a restless, active imagination (without being in the least a dreamer). These attributes were intimately and harmoniously blended. Mental concentration on concrete problems played the greatest part in the scientific achievements of his life. Liebig himself has told us that the quiet and the freedom from interruptions in the small town of Giessen enabled him to accomplish what it would have been impossible to do in a large city. However, his work at Giessen became so arduous, he tells us, that constant ill-health embittered his life. After his removal to Munich in 1853 his health improved, he could eat and sleep like other men, which had not been true for many years. He took no more students into his laboratory, and the glory of his life was in the past, in the twenty-eight years spent at Giessen. Others were carrying out his methods in a manner which made Germany supreme in chemical knowledge.

On his sixtieth birthday he makes a memorandum that his reception in Paris bordered on the miraculous. He says he has observed that when any one possesses a pronounced talent this awakens in all men an irresistible desire to contribute to its development. All help, as though they had counseled together to do so. But talent can be successful only when it is united with a definite constancy of purpose. Unfavorable external obstacles to the development of talent are small in comparison with those which lie in the man himself; for just as a natural force, be it ever so powerful, is ineffective in itself unless reacting with other forces, so a man who learns without trouble, one who has inherited definite intellectual gifts and preferences, can succeed only after he has learned a great many other things at the cost of greater effort than other people may have to make to acquire the same knowledge. For that reason he agrees with Lessing that talent is work and will.

A German biographer, quoting Shakespeare, says of him:

> His life was gentle; and the elements
> So mix'd in him, that Nature might stand up,
> And say to all the world, *This was a man!*

The story of Liebig's life carries its lesson to us to-day. American philanthropy is building great buildings for education, greater buildings than the world has ever seen. Those who visited this country last summer in connection with the XIII International Physiological Congress marveled at them and at their equipment and went home and wrote about it. We are building great comfortable homes for the students in our colleges; we are planning pent-house apartments for the internes in our hospitals. But who is concerned with the material welfare of the professor? The answer is, virtually no one. No pent-house apartments are thought of for him. And what are we doing to pick out the exceptional young man and develop him? To this question it may be stated that the National Research Fellowships initiated by the Rockefeller Foundation on the advice of the former professor of experimental medicine at the University of Pennsylvania, Dr. Richard M. Pearce, have done a vast amount of good (written the day before Dr. Pearce's death). It is said that privately endowed universities can not undertake this task. However, we might also welcome a return to the older method of the personal touch of Alexander von Humboldt, which magnified Liebig's opportunities, of the personal interest in him of the Grand Duke, and of the "truly fatherly benevolence" of Schleiermacher. The supporting influence of these three enabled a brilliant young man to shed undying glory on his country.

For the most part this personal touch is lacking in this America of ours. Money is given, and that is thought to suffice. The money is devoured by buildings and then by the routine necessities of running them. But support should be given to the education of brilliant young men who will work, support which follows through to the end. Work is the surest criterion. If a young laboratory man, be he ever so brilliant, spends his time at his desk at best indulging in philosophic thought, it is wise to get rid of him entirely, perhaps through removal into another environment which incites him to work. It is easy enough to distinguish between the workers and the drones. It is easy enough to distinguish between brilliancy and stupidity. But there is very inadequate machinery to give exceptional education to the brilliant worker. Not only this, but one should also remember that the most highly gifted professors, unless they have private means, lead lives of self-inflicted poverty.

It was believed at Yale at the time of Liebig that chemistry, like virtue, should be its own reward.

At the present time we should be alert to the fact that our over-organized university machinery is not producing as many real scientific men of the highest intellectual caliber as our material resources, if not our national pride, justify. German universities have always been able to fall back upon state funds when aid is needed, because the universities there are considered to be a part of the glory of the state itself. This attitude is too little appreciated in our own country.

The modern furor about changes in the curriculum matters little. The most important fact is that the student, before he begins to think, must have something to think about. And this involves learning not only what he likes and what is easily acquired, but also, according to Liebig, a great deal that he does not like at the expense of his will power.

Carl Voit was a physiologist with a physician's training, and he was able to give more of a physiological interpretation to the problems of metabolism than was Liebig. Pettenkofer and Voit built the first respiration apparatus for the determination of metabolism in man. Voit determined the metabolism in human diabetes and in leukemia as early as 1866. He always taught that one case carefully examined gave more information than the statistical array of hundreds.

In our own country metabolism work has been carried on largely as an extension of the German background. F. G. Benedict, Boothby, DuBois and I have been greatly interested in the subject. Recently, Richardson, Loebel and Shorr have been using the Warburg apparatus for the determination of the metabolism of thin slices of living isolated tissue. Just as in the case of a man placed in the respiratory calorimeter, the respiratory quotients of the isolated tissue vary with the food provided in the surrounding medium. When glucose is added to the medium, the respiratory quotient and the intensity of oxidation both rise, thus manifesting the phenomenon of the specific dynamic action of burning carbohydrate just as it occurs in man.

Recently these same authors have been investigating the respiratory phenomena of the tubercle bacillus. DuBois said the other day that he could map out a ten-year program for work along these lines.

So it becomes apparent that each generation of workers approaches a clearer appreciation of the phenomena of metabolism. It is far from complete. It is only through joyous work that it will be carried on, through work so rewarding that it would make one feel like dancing around a table, just as Gay-Lussac and Liebig did. It will be finished only when a knowledge of life itself is complete.

Sir James Jeans, in his recent book, "The Universe around Us," says that if one takes the height of a large Egyptian obelisk as the measurement of the time since the birth of the earth out of the mass of the sun, then the life of man on the earth would be represented by a penny on the top of the obelisk, and the time during which man has been civilized, or 5,000 years, would be represented by the thickness of a postage stamp. He estimates man's probable future in terms of additional time to exceed the height of Mont Blanc put on top of the penny and adds:

> As inhabitants of the earth we are living at the very beginning of time. We have come into being at the fresh glory of the dawn and a day of almost unthinkable length stretches before us with unimaginable opportunities for accomplishment. Our descendants in far-off ages, looking down this long vista of time from the other end, will see our present age as the misty morning of the world's history. . . . By what light we have, we seem to discern that the main message . . . is one of hope to the race and of responsibility to the individual—of responsibility because we are drawing plans and laying foundations for a longer future than we can well imagine.

THE RELATIONSHIP BETWEEN SCIENCE AND ENGINEERING[1]

By Dr. GANO DUNN
NEW YORK, N. Y.

SCIENCE has worked so many miracles and stands so high in popular esteem that her name is borrowed to dress up all sorts of causes that want to make a favorable impression. In consequence of this there is confusion as to the meaning of the term. We even hear of the science of pugilism.

A similar broadening and thinning has occurred in the term engineering, of which there have already developed over fifty varieties, one of which is called human engineering.

Notwithstanding all the pulling and hauling which each term has had to undergo in the struggle of new ideas and developments to attract public favor, in this heyday of the scientist and of the engineer when their fields often merge or overlap, there is a fundamental distinction between them, which, however, is not incompatible with the closest of relationships.

What is this fundamental distinction?

Science is a method of arriving at knowledge, and it is also the body of knowledge arrived at. The dictionary calls it an ordered knowledge of natural phenomena and the relation between them. It has also been called that process of reasoning based upon observed data and working hypothesis which by inductive and deductive procedure and experiment leads to new knowledge.

There has been a constant growth in the conception of what science is from the time when it was called natural philosophy down to the present when its field includes practically everything that can be considered objectively.

Science is as ancient as the classics and is in fact part of the classics notwithstanding the antithesis that is sometimes set up between the two as representing opposite poles of programs of education.

Modern science began with Galileo. He founded it not so much by the great discoveries he made as by the way he made them. There is no scientist to-day who does not consciously or unconsciously follow in that great Italian's footsteps, footsteps that go over the ground of observation, hypothesis, deduction and confirmatory experiment.

By shutting the mind as far as possible to all human prejudice and influence of feeling, save only the divine fire of imagination which creates the working hypothesis, science learns to discern in the order of nature paradoxes that are found to be truths, and new knowledge that is revolutionary.

Between the pebble and the mountain, between the worm and the man, science sees the superficial difference and the profound resemblance. Nothing is so insignificant as to be foreign to her scope. Her generalizations are in turn regeneralized, until, looking back upon her path, we acquire some measure of what her future may be.

They are no idle boasts, those legends written under the dome of the beautiful temple of science in Washington, "Pilot of Industry," "Conqueror of Disease," "Multiplier of the Harvest," "Explorer of the Universe," "Revealer of Nature's Laws," "Eternal Guide to Truth."

The priests who sacrifice in her temple know the joys of the freedom of the human intellect, and those who pity their sometimes apparent isolation from the world themselves are to be pitied for their own exclusion from the scientist's ecstasy of thought.

But beside her priests science has her worshipers who go out into the world and are a part of it. They are the engineers.

Engineering is the art of the economic application of science to the purposes of man. Of this definition every term is pregnant.

Science in the sense of a body of knowledge was applied to the purposes of man when our prehistoric progenitor first jumped upon a log to float across a river instead of swimming, but for several reasons that was not what we now mean by engineering.

In Egypt, Greece and Rome, as in middle age China and elsewhere in the world, we have great engineering works, but the relation of these to the scientific knowledge of their day, while of absorbing interest, was on a different basis from that which underlies the present economic age we live in.

Engineering as we know it is a new profession, born about 1750, the child of the industrial era. As industries have grown and diversified with the progress of science, the present vast field of the engineer has been created.

We do not call the first man to do a thing an engineer because he invented it. It is only when he begins to do it over and over again for the purposes of man that he earns this designation. While the terms inventor and engineer often describe the same man, it is because he combines both functions.

He is an engineer when he applies science as an art. An art is something to be done rather than something to be thought. It involves constant repetition. It implies skill gained in repetition. It implies improvement and it implies style.

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[1] Address given before the Alumni of Columbia University on February 12.

But of the many kinds of art, fine arts and useful arts, the engineer deals only with those that are useful. Utility is the standard by which his function stands or falls.

And how is utility measured? It is measured by the economic test. In this hot crucible of the economic test all his works are tried. He is an engineer only when he can do with one dollar what any fool can do with two.

It is because his art deals with dollars and economic relations that he is bound into the great business structure of society, and being bound into this structure he must be a man among men. He must be able to make his views prevail, to persuade, to contend, to give blows and to take them.

The scholar in his closet or the scientist in his laboratory does not do these things. To the engineer they are every-day life.

And if his training neglects the great human mirrors of history and languages, particularly his own language, if his mind and his heart are insensible to the great social forces, if he but feebly develops the subtle qualities of character that make for personality, his career as an engineer is limited, no matter how much science he knows.

The realm of economics where he works is a human realm involving organization, leadership and sympathy, to say nothing of passion, ignorance and vanity. Value is its criterion rather than truth.

The business of the engineer is no business for the philosopher. To be trusted with the expenditure of other people's money is no calling for a dreamer. If the key to the scientist is thought, the key to the engineer is action.

Engineering is not related to all of science.

As a body of knowledge science is composed of many sciences. Their practical application gives rise to many arts not all of which are economic or practiced by the engineer.

The science of biology has its art of medicine. The science of anatomy has its art of surgery. The science of astronomy has its art of navigation. The sciences of mathematics, mechanics, physics and chemistry have their art of engineering, which is the art of the economic application of these sciences to the purposes of man.

THE WOODS HOLE OCEANOGRAPHIC INSTITUTION

By Dr. HENRY B. BIGELOW

DIRECTOR

It is gratifying to report that the study of the present status of oceanography made by the committee of the National Academy on that subject and their recommendations[1] have borne fruit in the incorporation of a new establishment for the study of the sea, the Woods Hole Oceanographic Institution. And it is still more encouraging to students in sea science that the Rockefeller Foundation has appropriated for the new institution funds sufficient to assure it an adequate building program and sufficient operating income.

The purpose of the new institution, as its name implies, is to carry on and to encourage the study of the sea in the broadest sense. Like the Marine Biological Laboratory, it is an independent organization, but similarly assured of informal association with other educational and research institutions through the personnel of its trustees. The initial board is as follows: Dr. Thomas Barbour, Dr. Henry B. Bigelow (director), Dr. William Bowie, Dr. E. G. Conklin, Mr. Newcomb Carlton, Dr. Benjamin M. Duggar, Dr. Frank R. Lillie (president), Dr. John C. Merriam, Mr. Seward D. Prosser, Mr. Lawrason Riggs, Jr. (treasurer), Mr. Elihu Root, Jr., Dr. Harlow Shapley, Dr. T. Wayland Vaughan. The by-laws provide for an increase in the number of trustees up to twenty-four.

The choice of Woods Hole as the site for the headquarters of the new institution was reached only after a careful consideration of other possible situations along the Atlantic Coast of North America. The final decision was based on the combined advantage of close proximity to two world-famed laboratories of marine biology, on the one hand, and, on the other, on the exceptional opportunity for illustrative investigations that is offered by the neighboring waters.

The first of these inducements needs no explanation. The second depends in part upon the ease with which the transition from inshore to offshore waters can be reached from Woods Hole, on the abruptness of that transition and on proximity to the continental slope, and abyss. At the same time the Gulf of Maine, close at hand, with its tributaries, offers a more promising field for intensive investigations into the interaction between the physical-chemical and the biologic aspects of oceanography than any other sector of comparable extent along the coast of America. This follows from the fact that deep troughs, freely open to the ocean, enclosed sinks, a varied coast-line, a wide range of depth and offshore banks supporting some of the most productive of sea fisheries can all be reached within a few hours' sail from Woods Hole, while the transition from regions of extreme turbulence to waters more stable can be followed within short distances. The thermal diversity (regional, bathymetric and seasonal) is also wide, with temperatures ranging within a few miles of Woods Hole, and at different seasons, from below the freezing-point of fresh water to values almost tropical. A wide variation in the fertility of the local waters for pelagic plants is reflected by variations in the mass productions of the latter, while the faunal associations (including the planktonic) are equally diverse and abundant.

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[1] Science, 71: 84–89.

In short, there is hardly an oceanographic problem but can be hopefully attacked close to Woods Hole, unless primarily associated either with tropical shallows, with Arctic ice or with mid-oceanic conditions. The northeastern coast of the United States with neighboring parts of Canada is the most convenient headquarters for studies in the last two of these fields combined, because of nearness on the one hand to the ice-laden Labrador current (chief discharge of Arctic waters into the Atlantic) and on the other to the open Atlantic basin, with Bermuda in the offing as the possible site of a future substation.

The preceding remarks introduce one of the most important features of the institution's program, namely, that it expects to own and operate a seagoing ship, of moderate size, with convenient living quarters, capable of extended voyages and equipped to carry on investigations at all depths in the various fields of sea science. This is the more desirable because no other American marine laboratory independent of governmental control is at present in condition to do this. To make the most of such facilities, it is planned to keep the laboratory open with resident staff and the ship in commission the year round.

Plans for the laboratory building, docks, etc., are now being prepared and the institution hopes to open its doors by the summer of 1931. Before that time the trustees expect to announce in detail what facilities can be offered and what initial program of research is planned, based on the general purpose of offering every opportunity (compatible with work on shipboard) for participation by visiting oceanographers, whether from America or from abroad. This implies field-investigations in a variety of subjects, for which the offing of Woods Hole is favorable for the reasons just stated. The most essential activities of the institution may be expected to center around the work at sea. In this connection it must, accordingly, be recognized that the technical requirement of oceanography (necessity for obtaining the raw data for the major problems at sea) will confine the projects that can be undertaken at any one time to those that can be provided for simultaneously by the station's fleet. Consequently the activities, not only of the staff but likewise of many of the visitors, must be coordinated parts of a joint program. At the same time the laboratory purposes to offer every hospitality to individual workers who may elect to attack, independently, any problems the data for which can be obtained from the pier or from small boats.

At present few opportunities are open for the student of oceanography to gain experience in the technique of his subject, and the first-hand intimacy with the sea that he requires as a background for his detailed studies. The institution therefore expects to offer to university students instruction in oceanographic methods by participation both in the cruises and in the general work of the laboratory.

To carry out this part of the program, as well as to make the facilities available to qualified investigators, friendly and continuing relations with universities are obviously essential. Equally essential will be a constant endeavor to encourage the coordination of effort between various scientific institutions of this and other countries, that is especially needed in oceanography, where the area to be covered is so vast and where so many fields of science intertwine.

SCIENTIFIC EVENTS

THE DEGREE OF CHEMICAL ENGINEER AT CORNELL UNIVERSITY

IN response to an increasing demand on the part of industry for engineers who have had a specialized training in chemistry, the College of Engineering and the Department of Chemistry of Cornell University have been authorized by the Board of Trustees to offer jointly a curriculum leading to the degree of chemical engineer. This curriculum comprises five years of required and elective work. During the first four of these five years the student who expects ultimately to receive the degree of chemical engineer will be registered in the College of Arts and Sciences as a candidate for the degree of bachelor of chemistry, receiving that degree upon the completion of a definite four-year curriculum, the last two years of which contain a number of fundamental engineering subjects. During the fifth year of residence, the student will be registered in the College of Engineering as a candidate for the degree of chemical engineer and will receive that degree upon the satisfactory completion of this additional year of required and elective work.

In commenting on the innovation, Professor C. M. Dennis, head of the department of chemistry, stated that no student will be permitted to register for the degree of chemical engineer who has not completed the requirements for the degree of bachelor of chemistry or the full equivalent thereof, for years of observation and the testimony of alumni in industrial positions have convinced the Department of Chemistry that broad and thorough training in the various fields of chemistry is absolutely indispensable to the full success of the chemical engineer in his professional practice.

Professor Dennis points out further that there is a well-developed demand on the part of the chemical industries not only for graduates in chemistry and chemical engineering, but also for those who hold the degree of doctor of philosophy. "It is our expectation that many of the students who complete the course in chemical engineering will decide to continue for the doctorate, just as do many of those now who graduate as bachelors of chemistry."

Inasmuch as the fifth year of study for the degree of chemical engineer is graduate in character, the graduate school of Cornell University has ruled that this fifth year may be accepted as satisfying one year of the residence requirement for the degree of doctor of philosophy. In summing up the situation which exists in the chemical industry, Professor Dennis stated further:

> The student at Cornell University who wishes to prepare himself for the profession of chemistry may, therefore, receive the degree of bachelor of chemistry at the end of four years, the degree of chemical engineer at the end of a fifth year of study, and the degree of doctor of philosophy upon the completion of two further years of study and research. He may, of course, terminate his university residence at the end of the fourth year, or of the fifth year, or of the seventh year. There is demand in the chemical industries for all three groups of graduates. It should be borne in mind, however, that the training that the student acquires in the fifth year of study for the degree of chemical engineer is of great value for those who seek positions that have to do with the development and supervision of the operation of industrial chemical processes and plants. The advanced work leading to the degree of doctor of philosophy constitutes admirable preparation for responsible industrial positions that involve research or the supervision of research, and many of the larger chemical industries now require that their appointees hold this degree. Most universities and larger colleges also restrict appointments to higher positions on their staffs to those who hold the degree of doctor of philosophy.

GIFT OF THE GUGGENHEIM FOUNDATION TO THE GEORGIA SCHOOL OF TECHNOLOGY

THE committee of trustees appointed by Ambassador Harry F. Guggenheim, president of the Daniel Guggenheim Fund for the Promotion of Aeronautics, has authorized a grant of $300,000 for the establishment of an aeronautical engineering center in the south to the Georgia School of Technology.

Some months ago the trustees of the fund announced that a grant would be made for the establishment of such a center in the southern states to supplement previous grants made by the Daniel Guggenheim Fund for similar schools in other parts of the country. Twenty-seven requests were received by the fund from southern educational institutions, and each of these was investigated by a committee of four of the trustees of the fund appointed by the president.

In addition to personal inspection, a canvass of expert opinion was made among those in a position to judge which institution was best suited to carry out the kind of engineering work contemplated in the fund's plan. As a result of this inspection and investigation, three institutions were found to fill practically all the requirements of the fund, which rendered the final selection very difficult. Geographical location caused the elimination of a number of institutions which were otherwise well suited for the grant.

After much consideration and discussion, and giving due consideration to location, aviation environment, cosmopolitan characteristics of the student body and engineering requirements, in addition to the general requirements of the fund in connection with grants of this character, the committee finally decided to make the grant to the Georgia School of Technology.

This gift brings the total grants by the fund to educational institutions to about $1,500,000, as follows: California Institute of Technology, $350,000; Harvard University Graduate School of Business, $15,000; Massachusetts Institute of Technology, $264,000; Leland Stanford University, $195,000; University of Michigan, $78,000; University of Washington, $290,000; Georgia School of Technology, $300,000.

The award to the Georgia School of Technology is the final act of the fund, which officially ceased to exist on January 31, after having accomplished the purposes for which it was founded in 1926 by Mr. Guggenheim.

GRANTS BY THE COMMITTEE OF THE NATIONAL RESEARCH COUNCIL ON THE EFFECTS OF RADIATION UPON LIVING ORGANISMS

The committee appointed by the division of biology and agriculture of the National Research Council to collect and administer funds for the support of research upon the effects of radiation will complete the second year of its existence on June 30. After the period of solicitation and preliminary organization, as reported in Science, January 4, 1929, the committee found itself able to vote grants totaling over $25,000 for the year beginning July 1, 1929. These were distributed among some twenty-five investigators in amounts varying from $100 to $2,000. In addition to such financial support, the committee has made substantial assignments of apparatus donated by manufacturers, and has introduced individual investigators to the research departments of various industrial establishments for advice and other assistance. Two hundred milligrams of radium have been available as a part of this service and also radium emanations. It is hoped that similar assistance can be continued during the five-year period originally contemplated. In addition to its functions of solicitation and distribution, the committee has plans for a survey of the field of investigations.

As now constituted the personnel of this committee includes the following individuals:

Standing Committee: D. H. Tennent, L. L. Woodruff, W. C. Curtis (*Chairman*).

Sub-committee on Allotment of Grants: C. E. Allen, William Crocker,[*] W. C. Curtis, H. S. Jennings, G. H. Parker, L. L. Woodruff, D. H. Tennent (*Chairman*).

Sub-committee on Survey: A. F. Blakeslee, Janet Howell Clark, Max Ellis, C. S. Gager, F. B. Hanson, E. E. Just, S. O. Mast, H. W. Popp, B. M. Duggar (*Chairman*).

C. E. Allen, *Chairman*
Division of Biology and Agriculture
of the National Research Council

THE POSTPONEMENT TO 1931 OF AEROARCTIC'S FIRST EXPEDITION

It is with great regret that the postponement must be announced of the first expedition to the Polar regions of the International Society for the Exploration of the Arctic Regions by Means of Aircraft (Aeroarctic) which had been planned for April and May, 1930, on the *Graf Zeppelin*. Although all financial arrangements as well as the construction, preparation and tests of the necessary scientific apparatus and methods for the extended observational program had been made, it developed about the middle of December that, contrary to its expectations and agreement with Aeroarctic, the Luftschiffbau-Zeppelin Company could not obtain from underwriters insurance covering the ship and crew for the proposed Arctic trip—an obligation which the company had assumed as a part of its original contract with the society for the use of the airship.

The Central Executive Committee of the Society has now taken up independently the question of insurance and, according to latest advices, has received assurance of acceptance by responsible parties of the greater part of the insurance risk. Unfortunately this assurance was received too late to permit forwarding of the great amount of airship supplies and equipment necessary to reach the several base-stations in Norway and at Fairbanks, Alaska, in time for the needs of the ship in April, 1930. The meteorological conditions of the Arctic are unfavorable for the success of the expedition as planned after April and May.

Through the most energetic application of the various scientific and technical commissions of the society, the scientific equipment, methods and constructions had all been remarkably well prepared, involving an expenditure of 350,000 marks, according to the information received from the Central Executive Committee. Thanks to the enthusiastic endeavors of the citizens of Fairbanks through its Commercial Club, the Territorial Government of Alaska and the Alaska Road Commission of the U. S. War Department, an especially well-fitted landing field has been prepared at Fairbanks involving an expenditure of about $12,000, all of which, except for $1,800 supplied by the society, was provided locally.

That the executive committee of the society fully expects to realize in 1931 its carefully laid plans for 1930 is indicated by the following extracts from a letter dated January 20 at Berlin:

> The Executive Committee of Aeroarctic takes this opportunity to request all the national sections to continue to work most energetically for the achievement of the society's purposes. The committee is convinced that the accomplishment of the investigational program is of the greatest economic and scientific importance. It will put forth all its forces to insure that the expedition takes place in April to May, 1931.
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> Aeroarctic is under special obligation to the governments of Germany, U. S. S. R., Norway, Denmark, Spain, United States and Canada, which have taken such great interest in the practical advancement of the enterprise. The committee accordingly requests the presidents of the national sections to express the thanks of the society to the proper offices of the above-named governments and to request their support of its future plans.

As in all pioneer work such as this, initial delays and disappointments must serve only to spur on its sponsors. The importance of increasing our geophysical knowledge of the Polar regions is so great in every sense that the delay in the realization of the plans of the society will doubtless be compensated for in the greater achievement which must come with any effective realization of these plans in 1931.

JNO. A. FLEMING
Acting Vice-president, American Section, Aeroarctic

WASHINGTON, D. C.
FEBRUARY 28, 1930

SCIENTIFIC NOTES AND NEWS

DR. CHRISTINE LADD-FRANKLIN, lecturer in psychology and logic at Columbia University, died on March 5, in her eighty-third year.

DR. ROBERT W. WOOD, professor of experimental physics and chairman of the department of physics of the Johns Hopkins University, has been elected an honorary member of the Academy of Sciences of Leningrad.

THE Franklin Institute has awarded Franklin medals for the year 1930 to Sir William Bragg, director of the Davy-Faraday Research Laboratory of the Royal Institution of Great Britain, in recognition of his original and valuable contributions to the knowledge of atomic structures and of his inspiring leadership of the Royal Institution; and to Dr. John F. Stevens, because of his solutions of the engineering problems involved in making the plans and effecting the engineering organization for construction of the Panama Canal, and because of his distinguished success in the location, erection and administration of railroads, both in the United States and in foreign lands. The medals will be presented at the annual medal-day exercises of The Franklin Institute, to be held in the hall of the institute in Philadelphia on the afternoon of May 21. Both Sir William and Dr. Stevens will be present to receive their medals and will read papers before the meeting.

THE Brooklyn Polytechnic Institute, which has never given an honorary degree since it was founded seventy-five years ago, will break its custom to confer upon Rear Admiral Richard E. Byrd the title of doctor of science at the annual commencement exercises in June. The people of Virginia will present a sword of honor to Rear Admiral Byrd under a resolution passed by the General Assembly.

THE George Montefiore prize for the year 1929 has been awarded to R. D. Evans and C. F. Wagner, Westinghouse engineers, in conjunction with three other engineers—Algeri Marino, of Rome, and H. Parodi and Pestarine, of Paris. This triennial prize presented by the Fondation George Montefiore of Liége, Belgium, for the best original work contributing to scientific advancement in the technical applications of electricity was given to Messrs. Evans and Wagner for their papers on "Studies of Transmission Stability" and "Static Stability Limits and the Intermediate Condenser Station." The amount awarded to Messrs. Evans and Wagner was 3,000 Belgian francs. The two previous Montefiore prizes of 1925 and 1922 were awarded to Dr. J. B. Whitehead, professor of electrical engineering and dean of the faculty of engineering of the Johns Hopkins University, for his papers on "Gaseous Ionization in Built-up Insulation" and "The Corona Voltmeter and the Electric Strength of Air."

THE Colorado Engineering Council on January 23 presented its gold medal of award to A. J. Weinig for meritorious engineering service in the field of metallurgy, "in recognition of his valuable services to the mining industry of Colorado and the whole nation, for his application of the theoretical to the practical in metallurgical practices and for his contributions to improvements in the flotation method of concentrating ores."

SIR ALFRED YARROW has been elected an honorary member of the British Institution of Civil Engineers.

GEORGE STUART GORDON, president of Magdalen College and honorary fellow of Merton College, Oxford; Professor Owen Willans Richardson, director of research in physics, King's College, London; Mr. Henry Thomas Tizard, rector of the Imperial College of Science and Technology, have been elected members of the Athenæum Club, under the provision which empowers the annual election by the committee of a certain number of persons of distinguished eminence in science, literature or the arts, or for public service.

DR. A. C. D. CROMMELIN has been elected president of the Royal Astronomical Society, London.

DR. WILLIAM H. ROBEY, clinical professor of medicine at the Harvard Medical School, has been reelected president of the American Heart Association. He is also president of the New England Heart Association.

AT Harvard University Dr. L. W. Collett has resigned the professorship of geology which he has held since 1928; Dr. George Bogdan Kistiakowsky, of Princeton University, has become assistant professor of chemistry.

Dr. Charles W. M. Poynter, who has been acting dean of the University of Nebraska College of Medicine, Omaha, since September 1, 1929, has been made dean of the college and superintendent of the medical college hospital. He joined the university faculty in 1905 as professor of anatomy.

Dr. T. J. J. See, who, as a captain in the navy, has been in charge of the naval chronometer and time station at Mare Island, California, for the past twenty-seven years, has retired from active service, having reached the statutory age of sixty-four years.

We learn from *Nature* that the Medical Research Council has appointed Air Vice-marshal David Munro, on his retirement as director of medical services, Royal Air Force, to be secretary of the Industrial Health Research Board in succession to Mr. D. R. Wilson, lately appointed deputy chief inspector of factories at the Home Office.

Dr. Gustav Klein, who, as successor to Professor Molisch at the University of Vienna, holds the chair of plant physiology, has been asked by the I. G. Farben-Industrie in Ludwigshafen, manufacturers of chemicals, to take over the direction of its newly created cancer institute, which is said to be the largest in Europe. His special field will be researches on the etiology of cancer.

Dr. C. B. Jolliffe, of the Bureau of Standards, on March 1 took office as chief engineer of the Federal Radio Commission.

Robert P. Herwick, assistant in pharmacology in the University of Wisconsin, has been appointed acting state toxicologist, to succeed Dr. Clarence W. Muehlberger, who is joining the Scientific Crime Detection Laboratory at Northwestern University.

Dr. Louis Cohen has been appointed superintendent of the Otisville Sanitarium, Otisville, New York, the New York City tuberculosis institution.

W. H. Monsson, chemist on the pulp and paper staff at the U. S. Forest Products Laboratory at Madison, Wisconsin, has left the laboratory to join the Munising Paper Company.

Dr. Ira L. Kaplan has been appointed director of the New York City Cancer Institute, to succeed Dr. Isaac Levin, in a general reorganization of the medical board of the institute. The post of assistant director, newly created, was filled by Dr. Robert P. Wadhams, a colonel in the medical unit of the National Guard. He also is a teacher at the New York University Medical School and a visiting surgeon at Bellevue Hospital.

After visiting most of the countries of Central Europe and working their way well into Asia, H. L. Westover and W. E. Whitehouse, plant explorers of the Bureau of Plant Industry, have returned to the United States, bringing several hundred new plant varieties, principally alfalfa and fruits.

Professor Samuel J. Holmes, of the department of zoology of the University of California, who is now spending his sabbatical year studying in Europe, recently lectured by special invitation before the Eugenics Society of England, at the Royal Society headquarters in London. The subject of his lecture was "Family Resemblances in Mental Traits and the Weakness of the Environmental Explanation."

Dr. Carl Størmer, of the University of Oslo, known for his work on the aurora polaris, is visiting the University of London.

Dr. Jon Alfred Mjoen, director of the Norwegian Government Laboratory at Oslo and chairman of the Consultive Eugenics Commission of Norway, gave on March 6 an illustrated lecture on "Why Nations Rise and Fall" at the University of California under the auspices of the American Eugenics Society and the University of California Extension Division. Dr. Mjoen plans to spend some time on the Pacific Coast making a special study of race and immigration problems.

Dr. Harlow Shapley, director of the Harvard College Observatory, delivered the annual Sigma Xi lectures at the University of North Carolina on February 13 and 14. The titles of the lectures were "Order Among Star Clusters and Nebulae" and "From Electrons to Galaxies."

The Gehrmann Lectures for 1929–30 at the University of Illinois College of Medicine will be delivered on March 27 and 28 at 4:30 p. m. by Dr. Simon Flexner, director of the Rockefeller Institute of New York City. The titles of the lectures will be, respectively, "The Epidemiology of Poliomyelitis" and "Epidemic and Post Vaccinal Encephalitis and Allied Conditions."

Dr. William H. Park, professor of bacteriology and hygiene at the University and Bellevue Hospital Medical College, New York City, lectured on March 14 before the New York University Chapter of Sigma Xi on "The Etiology and Prevention of Respiratory Diseases."

Dr. K. Lark-Horovitz, professor of physics and director of the physical laboratory at Purdue University, addressed the local chapter of the Sigma Xi on

March 1 on "Recent Progress in the Art of Glassmaking."

PROFESSOR EDWARD L. THORNDIKE, of Teachers College, Columbia University, will be the second lecturer during the current year on the George Slocum Bennett Foundation at Wesleyan University. The subject of the first lecture will be "The Psychology of Learning by Repetition," and of the second "The Psychology of Learning by Rewards and Punishments."

PROFESSOR G. H. PARKER, of Harvard University, addressed the American Academy of Dental Science on March 5 on "Certain Aspects of Evolution and Heredity."

DR. ESMOND R. LONG, professor of pathology in the University of Chicago School of Medicine, will deliver the sixth Harvey Society Lecture at the New York Academy of Medicine, on the evening of March 20. His subject will be "A Chemical View of the Pathogenesis of Tuberculosis."

DR. DONALD C. BARTON, consulting geologist of Houston, Texas, completed on February 28 a series of lectures on geophysical methods for the department of geology of Columbia University.

A. L. KIMBALL, of the General Electric Company, spoke to the students and teachers of the department of physics at Amherst College on February 19. His subject was "Elastic Properties of Matter." Mr. James J. Lamb, technical editor of *Q. S. T.*, the official organ of the American Radio Relay League, spoke recently before a group of Amherst College students interested in radio communication. Through the generosity of an alumnus the department of physics is to be equipped with modern apparatus for work in this field.

THE forty-second annual meeting of the American Physiological Society will be held at the University of Chicago from March 26 to 29, with other societies forming the Federation of American Societies for Experimental Biology.

THE seventy-seventh annual meeting of the American Pharmaceutical Association will be held in Baltimore from May 5 to 10. This includes the meetings of the National Association of Boards of Pharmacy, the American Association of Colleges of Pharmacy, the Conference of Pharmaceutical Association Secretaries and the Conference of Pharmaceutical Law Enforcement Officials.

THE sixty-second annual meeting of the Kansas Academy of Science will be held at the Kansas State Teachers College at Hays on April 18 and 19. Papers will be presented in two general sessions on Friday, April 18, and one on Saturday, April 19. There probably will be a section meeting in chemistry and physics and another in psychology. The presidential address by Dr. W. B. Wilson, of Ottawa University, will be given following the banquet on Friday evening. His address will be on the value of an academy of science to the state. Later in the evening Dr. T. D. A. Cockerell, of the Department of Biology of the University of Colorado, will deliver an address under the joint auspices of the academy and the college on "A Naturalist Around the World." Dr. Cockerell will act as a representative of the American Association for the Advancement of Science. A trip to the Hays Branch Experiment Station of the Kansas State Agricultural College is being planned by the local committee of the academy at Hays.

THE entire colony of 700 to 800 experimental animals of the Food Research Laboratories, Inc., of New York City, was recently destroyed by asphyxiation due to the improper functioning of special gas radiators. Having been informed by experts that the catastrophe must have been precipitated by some human agency, a reward of five thousand dollars has been offered by Dr. Philip B. Hawk, the president of the corporation, for the arrest and conviction of the guilty person or persons. Detectives are actively investigating the matter.

THE residue of the estate of the late Elizabeth R. Stevens, of Swansea, Massachusetts, said to amount to $5,000,000, will be divided among the Union Hospital, Wellesley College, Mount Holyoke College, Massachusetts Institute of Technology, Massachusetts Eye and Ear infirmary and the Joseph Case High School of Swansea.

IT is announced at Swarthmore College that only $175,000 must be raised to complete the endowment fund of $2,000,000. The list of large donations is headed by one of $675,000 from the Rockefeller Foundation, which brought its total contribution to $1,350,000 within a year. Edward S. Harkness, of New York, contributed another $250,000, after having given a similar amount last spring. A conditional promise for a gift of $335,000 was obtained from the Julius Rosenwald fund. Another foundation has given an informal assurance of $150,000. Lessing J. Rosenwald, of Philadelphia, contributed $15,000, which can be used, principal or interest, at the discretion of the president of the college. From an anonymous donor came $400,000 for the endowment of the department of biology in the name of Dr. Edward Martin, and another $200,000 for a building in which it can be housed. This same donor previously had given $300,000 for the same purpose.

Mr. George F. Baker, of New York, who several years ago made a gift of $1,100,000 to Dartmouth College for construction of the Baker Memorial Library, has given an additional $1,000,000 for the maintenance and operation of the library. The library was dedicated in June, 1928, as a memorial to Mr. Baker's uncle, Fisher Ames Baker, a Dartmouth alumnus of the class of 1859.

The vice-chancellor of the University of Cambridge has announced that the Royal Society, in virtue of its reversionary interest in the residue of the estate of the late Mr. E. W. Smithson, holds a sum yielding about £1,200 a year, and that the regulations now published have been adopted by the Royal Society after consultation with the council of the senate in order to give effect to the terms of the bequest. The Regent House will be asked to pass a grace to the effect that Professor Seward, master of Downing; Mr. W. H. Mills, of Jesus College, and Mr. R. H. Fowler, of Trinity College, be appointed members of the committee for the administration of the Smithson Research Fund. The Royal Society will appoint four members of the committee. The committee will devote the income of the fund, or such part of it as may be necessary, to the establishment and support of a fellowship for research in natural science, with a view to the discovery of new laws and principles. It is to be called the Smithson research fellowship.

Industrial and Engineering Chemistry states that Mr. Francis P. Garvan has come to the aid of the American Chemical Society, and has enabled the directors to vote a budget for 1930 which is $95,000 in excess of its normal income, thus enabling the *Journal of the American Chemical Society* to publish promptly all accepted articles, which had accumulated to the extent of some six regular issues, and to meet the normal increase of the year. The foundation will also meet the increased needs of *Chemical Abstracts* and the *Analytical Edition of Industrial and Engineering Chemistry* for the coming year.

Through the generosity of Merck and Company, of Rahway, New Jersey, a fellowship in analytical chemistry with a stipend of $1,000 has been established at Princeton University for the academic year 1930–1931. The purpose of the fellowship grant is to foster fundamental research in the development of new or improved qualitative and quantitative analytical methods.

The University of Pennsylvania has received from Mr. Eldridge R. Johnson, a trustee, $250,000 for the further endowment of the Eldridge R. Johnson Foundation for Research in Medical Physics. Mr. Johnson's gift formed part of a $500,000 contribution which he made in connection with the effort of the university's trustees to meet deficits incurred by the university and to provide it with the nucleus of an adequate endowment fund. His latest gift raises the total endowment of the foundation to $850,000.

The Jordan-Eigenmann collection of fishes recently secured from Indiana University for the California Academy of Sciences by Dr. Evermann has now arrived at San Francisco where it is temporarily stored in the basement of the Steinhart Aquarium of the academy. Dr. Evermann, Mr. Alvin Seale, superintendent of the aquarium, and Mr. H. Walton Clark, assistant curator of fishes in the academy museum, together with several student assistants, spent the entire month of October in packing the collection and loading it in a box car for shipment west. The collection is one of the largest and most valuable in America. It contains more than 220,000 carefully selected specimens representing an unusually large percentage of the known species of North, Middle and South America. The shipment was made in about 100 large earthen jars, 13 large boxes and about 500 large cartons made especially for the purpose. The total weight of the shipment, including containers, was 36,000 pounds. The packing was done under the immediate supervision of Messrs. Seale and Clark and the loading of the car under Mr. Seale's supervision. The fact that the shipment reached its destination without the lose or injury of a single specimen speaks well for the care and excellent judgment shown by Mr. Seale and Mr. Clark. Such a shipment so eminently successful is probably without parallel in this country. The collection is now being opened up and placed on temporary shelving in a fire-proof room where it will be available for study and from which it will be transferred in the near future to permanent quarters especially constructed for the academy's ichthyological collections in the east wing of the academy's museum now under construction. This Jordan-Eigenmann collection, together with the very rich and valuable Jordan collection of about 100,000 specimens at Stanford University, will make this the ichthyological center for the entire Pacific area.

The *Journal* of the American Medical Association reports that the establishment of a department of medical and surgical research is being arranged by the Ohio State University. Creation of the department was authorized by the Board of Trustees as an expansion of the work of the college of medicine. The purpose will be "to coordinate the medical research in medical and surgical fields in the college, to work with the clinical members of the present staff and to inaugurate a program of scientific investigations that should be very fruitful of results." The personnel will include a professor, an assistant, technician and clerical assistants. According to the dean, the new department "promises to greatly enhance the usefulness of the college of medicine in scientific and clinical medical fields." The college of medicine is the oldest unit of the Ohio State University.

The New York *Times* writes editorially as follows: "To further the interests and usefulness of science the Association of Scientific Workers was organized in Great Britain two years ago. Small though it be, the association has made its influence felt on both Lords and Commons. Major Arthur Church, its energetic secretary and a doctor of science himself, stood for the House, was elected and promptly proceeded to organize no fewer than seventy of his fellow-members into what is merely the nucleus of a parliamentary science committee through which the association will endeavor to apply science in the service of the empire. Far from being an upstart, the parliamentary science committee, like most things British, has a respectable ancestry. Until 1866 the British Association for the Advancement of Science championed the cause of the physicist, biologist and chemist through a small parliamentary committee and thus succeeded in improving navigation and the weather-forecasting service; determining the conditions under which civil list pensions were to be awarded to scientists; raising the standard of scientific teaching; furthering the exploration of Africa by Livingstone, Speke and Grant, and inducing Tyndall and Huxley to express their opinions on the best method of introducing physical science into the curricula of the public schools. The example thus set may well be considered by Congress and American men of science. No government in the world conducts so much industrial and purely scientific research, through its bureaus, as ours. Yet the scientist plays no conspicuous part in our legislative halls."

DISCUSSION

THE PROPORTIONS OF THE GREAT PYRAMID OF GIZEH

In a recent most interesting address on "Mathematics before the Greeks,"[1] Professor Archibald incidentally enumerates various "mystical" interpretations of the proportions of the Great Pyramid. This reminded me of an explanation suggested by the photograph which hangs before me in my office.

Whatever the reason for the choice of dimensions, the proportions seem artistically perfect. Is this a delusion due to familiarity or is there a mathematical basis for such a conclusion?

The apparent angle φ between the opposite inclined edges of a pyramid varies, as the spectator travels around the pyramid, from $2 \tan^{-1} (d/h)$ to $2 \tan^{-1} (.707\, d/h)$, where h is the height and d is half the diagonal of the base. Now the dimensions of the Great Pyramid are such that the ratio of the apparent width of the base ($2d \cos \theta$) to the height varies from a maximum of 2.222 to a minimum of 1.572. If these values are plotted as a function of the angle θ, the average value is exactly 2, which is the value which corresponds to a right triangle. This means that if the pyramid were rotated in front of a distant observer, the apparent angle between the opposite edges at the apex would vary between 96° and 76.3°, but the average value would be the angle 90°. This follows mathematically from the fact that the ratio of h (481 feet) to d (534.4 feet) is exactly the ratio of $\sin \pi/4$ to $\pi/4$, that is 0.900.

Now let us consider the vertical section of the pyramid perpendicular to two faces, the section any architect would draw. According to the Encyclopaedia Britannica, the angle between each face and the base has the following values, for the four pyramids of Medum and Gizeh.

Name	King	Angle
1. Medum	Sneferu	51° 52′
2. Great Pyramid of Gizeh	Khufu	51° 52′
3. Second " " "	Khafra	53° 10′
4. Upper " " "	Menkaura	51° 10′

Why did the architect in each case choose an angle of about 52° instead of 45° or 60°? It is an interesting fact that for a right triangle having a lower angle of 51° 49.6′, the height is the geometric mean between the base and the hypothenuse, that is, the ratio of hypothenuse to height is equal to the ratio of height to base, giving a right triangle with perfect proportions. In the case of the first two pyramids the angle approximates this ideal angle within one part in a thousand. However, the fact that the third and fourth pyramids depart from this angle, one being slightly more and the other slightly less, suggests that the design was not controlled entirely by a mathematical formula, but was subject to modification according to artistic judgment, which, however, oscillated about the value given by the formula.

Gordon S. Fulcher

Corning Glass Works

THE NEW MADRID EARTHQUAKE—AN UNPUBLISHED CONTEMPORANEOUS ACCOUNT

I recently came upon the following record of observations of the New Madrid earthquake in an old journal in my possession of my great-grandfather, William Brown. The observations were made by him at his home three miles north of Hodgenville, Kentucky, and forty-six miles directly south of Louisville. This location was 225 miles slightly north of east of New Madrid. He has left numerous records in this journal, some of which have been published, that indicate the accuracy of his observations and records. The notes of the earthquake seem worthy of publication because accurate records of it made at the time are few and unexcited ones very rare.

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[1] Science, 71: 115, January 31, 1930.

> Mount Gilead Kentucky Earthquake on Sunday night Decr. 15th, 2 of the clock at night a severe shock of an earth quake was felt. The motion of shaking continued about 15 minutes. About half an hour after this shock was over another was felt less severe, continued only a minute or two. The next day, Monday morning the 16th, a little after sun rise another shock was felt, the tremor continued a few minutes. Two other slight shocks were felt that morning—the next shock was on Sunday about midday not so violent as the first. The weather for some days before had been dull and cloudy. Again on the night of the 30th instant a shock was felt. Again on Jany (Thursday) 23 1812 at 8 o'clock in the morning another severe shock was felt. The tremor continued for several minutes. When it had stilled another shock was felt which lasted a minute or two. On Monday morning Jany. 27th, a slight shock was felt—on Tuesday evening, 4th Feby 1812 a slight shock was felt. The trembling of the earth continued for several minutes suppd. 6 or 7—and a rumbling noise heard. These are the shocks that we have felt at this place. By report hardly a day passes but the trembling of the Earth is more or less felt. In time of the severest shocks to attempt to walk you feel light head and reel about like a drunken man. Again on the night of Thursday, the 6th Feby. about 4 o'clock A. M. a very severe shock was felt which lasted fully 15 minutes with a rumbling noise like distant thunder and three very distinct reports like cannon was heard at the end of it. Again on Friday night the 7th a smart shock at 8 o'clock then about 11 o'clock another less severe. Frequently you may feel a trembling in the Earth when there is no visible appearance of shaking. It has invariably been cloudy weather about the time of the shocks and rains or snow shortly after. Again on the night 20th Feb. about 9 or 10 o'clock 2 slight shocks were felt the last of which continued its tremor for more than 15 minutes. Again on Saturday night 22d about 10 o'clock another slight shock.[1]

There are not many contemporaneous accounts. Fuller republished in SCIENCE[2] most of Audubon's account in his "Journal." It was written two or three years after the occurrence and is inaccurate; he puts the date a year after it occurred, and the first shock as occurring in the afternoon while he was riding. Bradbury, the British botanist, happened to be at the very center of the disturbance, on the Mississippi River, and describes it carefully in his "Travels in the Interior of America." Bradbury was a trained scientific observer and, as might be expected, his account is the most valuable. In the *American Geologist*,[3] Broadhead brings together most or all of the other early accounts that have been published. Of these, the account of Eliza Bryan, of New Madrid, taken down four and one half years later by Lorenzo Dow, is the only one that is free from excitement and gives a chronological account of the shocks. Brown's record of the repeated shocks agrees closely with those of Bradbury and Bryan and is the only one that is equally temperate and detailed.

Bradbury mentions the previous appearance of a comet in the following words: "One of the men . . . attributed it to the comet that had appeared a few months before, which he described as having two horns."

Brown also refers to this comet in the note next preceding that of the earthquake in his journal as follows:

> A comet with a broomy tail appeared about the first week in September 1811 in the northern region of the Heavens. Its course appeared to be coming from the Northeast and making its way to the Southwest. Continued to be visible until about middle of Jany 1812. The last appearance of it was in the So. Western region of the Heavens.

It is evidence of his freedom from superstition that he does not suggest any connection between the comet and the earthquake.

WM. ALLEN PUSEY

BIOLOGICAL NOMENCLATURE

IN the issue of SCIENCE of January 10, Professor Needham renews, without enthusiasm, his proposal of 1910 of a system of numbering species in lieu of naming them. One serious objection to that plan is that it is much easier to remember names than numbers, and easier to associate names with species than to associate numbers with species. In a magazine article or an address to biologists most of them might recognize names of species, but few would recognize numbers. Furthermore, it is much more difficult to avoid mistakes in writing and printing names than in writing or printing numbers. A mistake in a figure makes the whole number wrong. A mistake in spelling a name may leave the meaning perfectly clear. In proof-reading a mistake in a number may be easily overlooked, whereas a misspelled name is likely to be noticed.

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[1] From Wm. Brown's "Journal," pp. 19 and 20, in University of Chicago Library.

[2] May 12, 1905, N. S. XXI, No. 541.

[3] Vol. 30, August, 1902.

Professor Needham's suggestion that trinomials be discarded entirely would only make a bad mess worse. Trinomial nomenclature, recognizing very slight differences by name, whether they be biological, geographical or environmental differences, must be relied upon to save the idea of species, based upon more important and constant differences. It is often necessary to discuss such races, and they can be designated intelligibly only by giving them names. To give them binomial names, thus placing them in the same rank as full species, would be biologically less accurate and would also greatly multiply the species which, to use Professor Needham's own phrase, do not "concern the general reader."

However, I am in hearty sympathy with Professor Needham's protest against the multiplication of genera, now rapidly reaching the point where one must "learn a new genus for almost every species." A vast number of genera now recognized would better serve the ends of science if regarded as subgenera. This splitting process is discouraging to students who would like to engage in biological work, and it makes most of the literature of biology usable to only a very few, neither of which results is desirable. If it were necessary to consider all these small groups genera, regardless of how slight the differences by which they are separated, nothing more need be said, but it is not at all necessary.

Genera are not of equal rank and can not be. Division of species into genera, families, etc., is a man-made system, purely for the convenience of men and women. The question as to whether a given group should be considered a genus or a subgenus is purely a matter of individual opinion, in most cases. It no more accurately represents nature to call most of these groups genera than to call them subgenera. A juryman explained that the jury could have agreed except for eleven obstinate men on the jury. Of course the specialist naturally considers his own brain-children more important than any others, but are they? Should he not consider the thousands of naturalists who are not specializing in his particular line? Should he not endeavor to make his writings and addresses intelligible to a large number of people instead of to two or three narrow specialists, and instead of trying to obscure or conceal his ideas from most of his readers and hearers? Using a well-known generic name, followed by a subgeneric name in parentheses, would indicate to both specialist and non-specialists what organism is under discussion, which is the real purpose of nomenclature, and the subgeneric name would sufficiently indicate the slightly differentiated group in which the specialist is interested. Those who believe that "the purpose of language is to conceal thought" from everybody else will continue to multiply genera, while those who use language to make their meaning plain to all who hear or read will relegate many genera to subgeneric rank.

UNIVERSITY OF COLORADO JUNIUS HENDERSON

A NATURAL CAT MUMMY

THE November–December, 1929, issue of *Natural History* prints the following statement:

> In a recent issue of *Palaeobiologia*, Professor Julius Vigh of Budapest describes a natural mummy of a house cat. After death the cadaver of the cat dried out thoroughly without decay and has been preserved for more than ten years.

The writer has in his possession a similar specimen which he has used for the past six years in lectures to his classes in paleontology at Brown University, since it is an illustration of how fossilization may originate through desiccation. The history of the specimen and its state of preservation may interest paleontologists and others.

The cat in its present state came into the writer's possession about 1911 or 1912 while he was a boy in high school at Plainfield, New Jersey. It had been found in a barn, under the following circumstances. The finder, a fellow student of the writer, had disturbed some hay which had long lain in a corner of the building. In so doing he came upon the dried body of the cat lying on its side. How long it had been under the hay there was no means of knowing, but certainly it had been there long enough for complete desiccation of what parts remained at the time of discovery. Turning the carcass over, an opening nearly as large as a tennis ball may be observed on the under (right) side, exposing nearly the entire visceral cavity from which all soft parts have decayed. These, and part of the left hind foot, the tail and most of the fur are missing, but otherwise the specimen is practically complete, even to the dried eyeballs and remnants of whiskers. The stiff, hard, resonant skin is drawn tightly over the bones in all parts, and the ears are dried to thin, parchment-like pockets. When first secured, the cat had a slight odor, but this long since disappeared, and the specimen has been kept for some seventeen or eighteen years without any preservative or particular care. To-day it shows no sign of further deterioration. Evidently, the viscera rotted away soon after death; and, this locus of decomposition having been removed even after the manner of preservation of the Egyptians of old, the rest of the body, partly shut off from the air by its hay covering, "kept" perfectly.

The manner of death may be surmised. There is evidence of mutilation prior to death. The missing tail may have been lost before or since the cat died; that can not be definitely determined. But the left hind foot is crushed, the bones protruding from the ragged fragments of dried skin, and the toes missing. The mouth gapes open, and the head is twisted sidewise in an unnatural attitude as if the animal died in a paroxysm. It seems probable that the foot was injured in some manner, possibly by being trampled upon by one of the horses kept in the barn where the cat was found. Finding itself wounded, the creature crawled into the hay and expired.

The writer recalls a similar case of a cat injured on a New England farm. This cat lost a foot in the mowing machine and crawled away to die in a small loft over a shed where it was subsequently found. Whatever was the actual fate of the mummified cat we may only guess, but the excellent specimen remains. Although not a true fossil, at least it is akin to the authentic remains, since it graphically demonstrates the preservation of such classic examples as the Moa skin and feathers from New Zealand caves or the ground-sloth skin and hair from the Americas, both fossils formed by desiccation.

BRADFORD WILLARD

BROWN UNIVERSITY

MOUSE OPOSSUM STOWAWAYS ON BANANAS

IT seems worth while to add another note relative to finding the small tropical marsupial Marmosa, known as the mouse opossum, as a banana stowaway.

Previously, Dr. L. A. Adams[1] recorded finding some of these marsupials, and Professor Geo. Wagner and also Mr. E. R. Warren[2] reported others.

A female with litter was brought to our laboratory on June 14, 1929, indirectly from a grocery store, one of an Akron chain store concern. It had been hiding in a bunch of bananas, quite possibly coming from Central America. I could determine the animal to the genus Marmosa, but not to species. This adult female, with total length of 28.5 cm, or 11.2 inches, including the tail which itself was 14.5 cm or 5.7 inches long, was smaller than the measurements given by Anthony for one species *M. isthmica,* and may possibly be the *M. zeledoni* he describes as typical from Central America.[3]

Nearly a dozen young were clinging to the mother, but they were hard to keep count of, unless the mother, who kept well secreted under leaves in a box, was much disturbed. She may have been thus disturbed previous to receiving and again was badly disturbed a week later in attempts to photograph her out in the bright light of the open. She was naturally inactive, secretive, though very much on the alert and seemingly nervous. She would snap viciously with remarkable speed when a hand or instrument was placed within a few inches of her head. The young clung with claws almost anywhere on the fur, but principally ventrally, and occasionally on the tail. A few times one of the young wandered off a few inches. When I approached it closely the mother would grasp it with the claws of one foot and speedily thrust it under her.

It was seemingly impossible to furnish the desired diet or a diet entirely adequate for lactation. The mother ate of bananas regularly, as much as possibly an eighth or a tenth of a banana a day. Following the information previously given that insects were normal food, various insects both dead and live were put near her, but there was no evidence of feeding upon these. Several young died in the early days of the two and a half weeks I had the mother alive in a box. Possibly some young had been abducted, but as I found parts of two bodies in the box it appears certain that the mother ate of her young. No other animals could have entered the box, since it was securely covered with a fine screen. Three young were alive for some days. Then one day only one was left. The next day the mother was gone, undoubtedly escaping after some one had removed her in order to handle her. Later she was found in an open jar of formaldehyde solution. Attempt at feeding the one remaining young with cow's milk was unsuccessful.

It seems of interest to add that the mother made a low, clicking, chirping sound quite uniformly when disturbed.

WALTER C. KRAATZ

DEPARTMENT OF BIOLOGY,
UNIVERSITY OF AKRON

SPECIAL CORRESPONDENCE

A BIOLOGICAL SURVEY OF LAKE ERIE

DURING the summers of 1928 and 1929 an extensive biological survey of Lake Erie was carried out through the cooperation of the U. S. Bureau of Fisheries, Buffalo Society of Natural Sciences, New York State Conservation Department, the departments of game and fish of Pennsylvania, Ohio and of the government of Ontario, and the Health Department of the City of Buffalo. The primary purpose of this survey was an inquiry into the reasons for the decline in the commercial fishery industry in the lake, and included in its scope the study of various biological, chemical and physical factors which bear an important relationship to the production of fish. For the successful operation of the program the steamer *Shearwater* was given by the U. S. Bureau of Fisheries, the maintenance of the vessel and salaries of the crew and several scientists generously financed by New York State and one or more specialists contributed by each of the other cooperating institutions.

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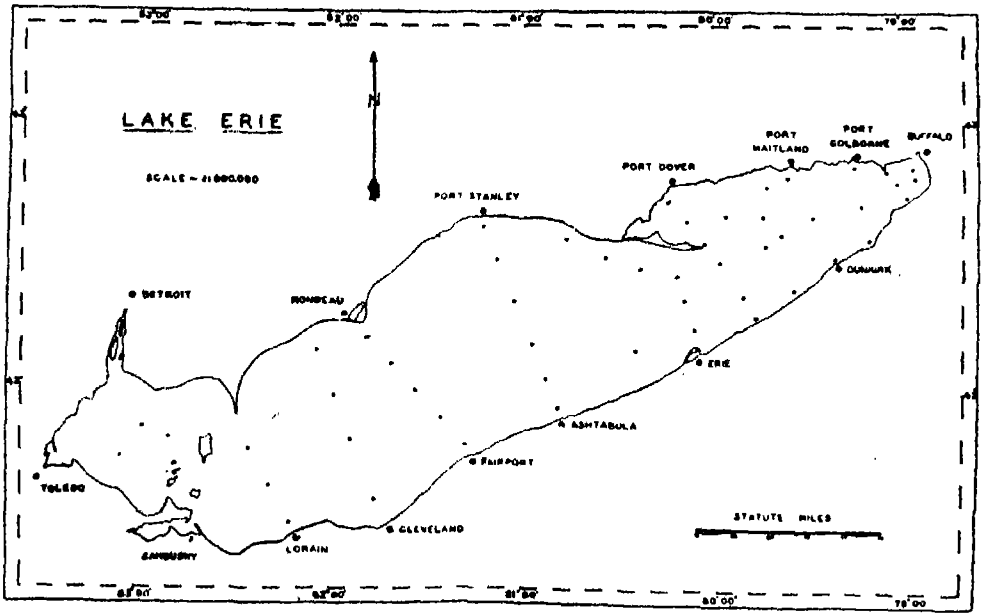
[1] SCIENCE, February 24, 1928.

[2] SCIENCE, April 20, 1928.

[3] Anthony, "Fieldbook of North American Mammals," p. 7.

Operations which were confined to the eastern portion of the lake during the preliminary survey in the season of 1928 were extended in the summer of 1929 to the entire lake. During the period from May to September in 1929 observations were made every month at a large number of selected stations which are shown on the map. These observations embraced a variety of special studies such as the spawning and growth of young fish, the production of phyto- and zooplankton, the physical hydrography, the chemistry as an index to normal lake conditions and extent of pollution, the lake sediments, etc.



Map showing location of stations visited monthly by the U. S. *F. S. Shearwater*, summer of 1929

The staff of investigators consisted of the following:

Charles J. Fish, Buffalo Museum of Science, director.
Charles K. Green, U. S. Coast and Geodetic Survey, hydrographer.
Marie P. Fish, Buffalo Museum of Science, ichthyologist.
Charles B. Wilson, Westfield Normal School, macroplanktonologist.
Paul R. Burkholder, Buffalo Museum of Science, microplanktonologist.
Reginald H. Pegrum, University of Buffalo, geologist.
Casimir J. Munter, Ohio State University, chemist.
Arthur H. Louden, Queens College, scientific assistant.

"A Preliminary Report on the Cooperative Survey of Lake Erie" covering the results obtained in the season of 1928 has been published as a *Bulletin* of the Buffalo Society of Natural Sciences. This report includes a discussion of the program and itinerary, topography, hydrography, bacteriology, chemistry, microplankton, macroplankton and ichthyology. A complete report upon the various phases of the investigation together with summary and conclusions is now in preparation.

PAUL R. BURKHOLDER
BUFFALO MUSEUM OF SCIENCE

SCIENTIFIC APPARATUS AND LABORATORY METHODS

DISPLAYING AND FILING MICROSCOPIC PREPARATIONS

THE method here described has been found most satisfactory after many years of experience with extensive series of demonstration material used in connection with courses in microscopic anatomy. A sketch of that portion of the preparation to be shown, with the necessary legends and explanations, is placed on a 5 x 8 inch cardboard having a drawing surface (Crescent mat board is very satisfactory).

This is covered with a 5 x 8 inch sheet of transparent celluloid (such as Eastman Kodaloid No. 3) and the two are bound together with 1-inch-wide black adhesive tape, such as is used for fastening shields on the inside of automobile windows (*e.g.*, Durwood 3A tape), as shown in the accompanying figure, front view. A little more than half of the width of the tape is folded on to the back (see Fig. 1). Ordinary white adhesive tape can be used just as well, but it becomes soiled very readily.

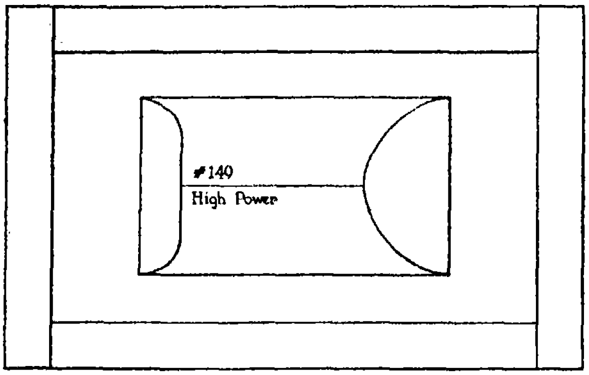


Fig. 1. Back view.

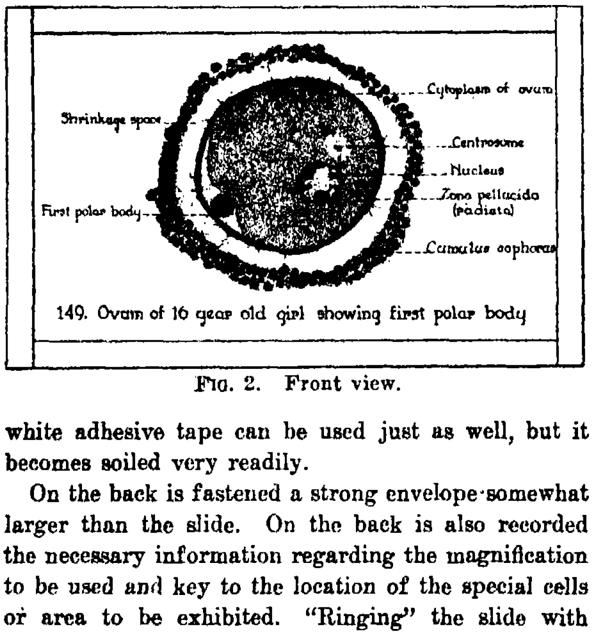


Fig. 2. Front view.

On the back is fastened a strong envelope somewhat larger than the slide. On the back is also recorded the necessary information regarding the magnification to be used and key to the location of the special cells or area to be exhibited. "Ringing" the slide with India ink or a diamond point may make some of this information unnecessary. When filed away, the slide is kept in the envelope of the corresponding card. The card and slide should bear the same number, and the number on the slide should be placed so that when the number is right-side-up the slide is properly oriented on the microscope. When in use the card is placed beside the microscope. The transparent cover prevents the sketch from being marred.

If it is desired to write the explanations with the typewriter, a thinner drawing paper is used which is pliable enough to be handled by the typewriter. The sheet containing the sketch is covered with the sheet of celluloid and backed by a 5 x 8 inch piece of stiff mounting board and the three bound together with the tape.

A photograph, with the necessary indicators and explanations put in by hand, may take the place of a sketch. A very light print on a mat surface may be used for the general outline and special areas, or particular cells sharpened up and focal depth increased by retouching with diluted India ink. Explanatory cards thus mounted may be prepared to accompany models and gross specimens that are used regularly for demonstration purposes.

These cards are neat, durable and inexpensive. They make for simplicity in filing. Slides of any size, up to sections of the entire hemisphere of the adult human brain, may be accommodated by merely selecting envelopes of the proper sizes. If gross specimens and models are used with microscopic preparations in the same demonstration, uniform explanatory cards can be made which may be filed away in the same cabinet when they are not in use. Carefully selected sets of well-labeled demonstrations to supplement loan collections and material actually dissected by the students in biological courses are becoming more and more imperative as the enrolment increases, since they make it possible to reduce the relative number of laboratory instructors in some cases.

A. T. Rasmussen,
Carol A. Fisher
Department of Anatomy,
University of Minnesota

A TANGENT METER FOR GRAPHICAL DIFFERENTIATION

This instrument is a simple device for the direct measurement of the tangent to a curve at any point. The derivative curve may then be rapidly and easily obtained by plotting the tangents. Since the measurements may be made as near each other as is desired, maxima, minima and points of inflection may be found without reference to the rest of the curve, as would be required by numerical methods such as finite differences.

Numerous applications will appear to those who do graphical work involving rates of change, especially in case the equation of the curve to be differentiated is unknown. The instrument may also serve as an aid in curve fitting. The biologist may use the instrument in determining the rate of growth of an organism, at any time, from the plot of the growth curve. Objective analysis of the graph of any equilibrium of a living system becomes possible directly without other information than the original graph of the observations. The saving of the investigator's time is apparent because it is possible subsequently to measure rates at intermediate intervals without repeating laborious numerical computations.

The instrument consists of a base cut out at the center to receive a flanged rotatable disk. The center disk is held in place by being bolted to the indicator, Fig. 1. The exact center of this disk is marked by crossed center lines on the under side, and an isosceles (or equilateral) triangular prism is placed odd face down on the upper side of the center disk in such a way that the lateral edge opposite the odd face is directly over the center. The main axis of the prism is perpendicular to the index line drawn on the under side of the indicator arm. A suitable opening for the prism should be cut through the indicator. All parts are made of transparent viscoloid.

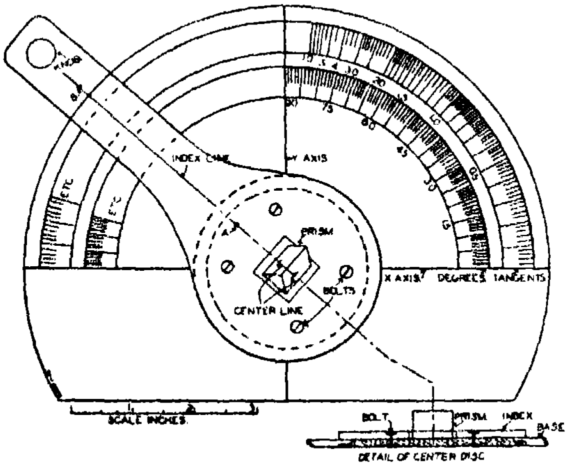


FIG. 1

The base is graduated with a protractor degree scale and with a tangent scale. Tangents to unity (45°) may be read directly to 2 parts in 100 and may readily be estimated to 1 part in 100. Above unity the magnitude of the tangents increases rapidly and the accuracy of the reading is proportionally less. The loss in accuracy does not appear greatly in the practical use of the instrument since many curves do not slope more than 60° and with greater slope the tangent may be obtained from the related function measured after the instrument has been rotated 90°. Increased accuracy may be obtained by increase in the size of the instrument and the number of divisions on the scales and by the use of a more transparent glass prism. When the slope of the curve is negative the tangent is read on the left-hand scale. (This scale is not completely illustrated in Fig. 1 because it is a mirror image of the scale on the right-hand side of the instrument.) The reading on the tangent scale is correct when the units of the abscissa and ordinate are equal; in other cases the readings must be multiplied by an appropriate factor.

To use the tangent meter place the crossed center lines directly over the point on the curve where the slope is to be measured, make the x- or the y-axis of the instrument parallel to the same axis of the curve by rotating the instrument and then turn the indicator arm until the image of the curve is seen through the prism to be a continuous line. Then the tangent to the curve at the point selected may be read on the tangent scale, or the angle that the tangent makes with the x-axis may be read on the protractor scale. When looking at the cross of the center lines from above the prism it is seen as two crosses, one at each side of the prism, due to the refraction of the prism (*cf.* Fig. 1). The tangent may be drawn to the curve by extending the line connecting two points made by pushing a pin through the holes A and B on the index line. For drawing tangents or normals to curves, where the operation is to be repeatedly performed, a convenient form of the instrument may be made by mounting a prism at the proper angle on a projecting section at the center of a straight edge.

OSCAR W. RICHARDS,
PERCY M. ROOPE
CLARK UNIVERSITY

SPECIAL ARTICLES

THE GERMINATION OF SEEDS, GROWTH OF PLANTS AND DEVELOPMENT OF CHLOROPHYLL AS INFLUENCED BY SELECTIVE SOLAR IRRADIATION

THE energy in sunlight ranges from the infra-red (or heat) rays, through the visible from red to violet and on into the ultra-violet—the short rays of sunshine so necessary to prevent rickets. Are each of these regions of solar energy equally necessary as aids to germination, development, growth and maintenance of existence, or do quality (wave-length) and quantity (intensity) of energy enter as important factors? Are certain wave-lengths and intensities of radiant energy used by plants for one purpose, while other regions and intensities of energy perform a distinctly different function and service? Do certain wave-lengths of solar radiation promote growth, while other regions of solar energy retard it? Is the development of chlorophyll chiefly dependent on the infra-red, visible or ultra-violet rays?

We have endeavored to answer these and similar questions by making physical measurements on the quality (wave-length) and quantity (intensity) of the radiant energy used, the amounts of chlorophyll developed and so forth and by conducting biological experiments on the number of germinations, heights and weights of plants and areas of leaves.

Effects produced under quartz-containing glass, ordinary window glass, amber and blue glass filters.—Quartz-containing glass transmits the whole of the visible portion and a very considerable part of the ultra-violet region of sunlight; ordinary window glass deletes the shorter ultra-violet wave-lengths in large part; amber glass transmits only the longer wave-lengths while blue glass transmits only the shorter visible and longer ultra-violet wave-lengths of incident radiant energy.

Employing Pittsburgh amber No. 48, Pittsburgh blue No. 56, vitaglass (quartz-containing glass) and ordinary window glass, our experiments have shown: (1) In general, the number of germinations is the greatest under vitaglass or ordinary window glass, comparable under the blue filter and least under the amber glass. (2) The average height of stalks increases as we pass from the plants grown under ordinary window glass to vitaglass, to the blue filter and finally to the amber glass. (3) The areas of the leaves are the greatest under vitaglass, less under ordinary window glass, still less under the blue filter and least under amber glass. (4) The weights of plants (stalks and leaves) as grown under the four filters are in the order: vitaglass, amber, blue and ordinary window glass. (5) The lengths and weights of the roots are of the same order of magnitude and arranged in the same sequence as the lengths of stalks and weights of plants. (6) The development of chlorophyll for each gram of plant (not dried) is greatest under vitaglass and decreases in the sequence of ordinary window glass, blue and amber filters.

A comparison of these biological results with the data regarding the percentages of various types of solar radiation transmitted to the plants indicates that the growth is greater under either the longer or shorter wave-lengths of sunlight than it is under the full complement (practically) of sunlight. The infra-red transmissions of the four filters are comparable, therefore this region of solar radiation does not appear to be the controlling factor. Furthermore, the growth under amber or blue filters, which transmit from 30 to 40 per cent. only of the visible portion of sunlight, is greater than under vitaglass or ordinary window glass which transmit about 90 per cent. of the incident visible light. The growth is greater, therefore, under a portion of solar radiation than it is under the full complement of sunlight. A spectrophotometric study of the amber and blue filters shows that there is a relatively small transmission of energy in the green region of the spectrum. The inference (which is substantiated quite definitely by the experiments under the group of seven Corning glass filters) may be drawn that the green region of the solar spectrum, which is the region of maximal energy of sunlight, is inhibitory in character so far as growth is concerned. Or we may say that the infra-red and red regions of sunlight, at one end of the spectrum, and the blue, violet and ultra-violet at the other extreme of the solar spectrum, are vital and stimulating to growth. The development of chlorophyll, however, is practically the same under the amber or blue filters but is greatest under vitaglass or ordinary window glass. From these experiments, in which we have used vitaglass, window glass, blue and amber filters, it can not be stated, however, whether or not the development of chlorophyll is dependent on the total quantity of energy transmitted by the filters or on the quality (presence or absence of certain wave-lengths) of the incident radiant energy.

Effects produced under spectral filters transmitting chiefly one quality only of radiant energy.—In order to limit more narrowly the quality and quantity of solar radiation incident on any group of seeds or plants we have used a set of special filters[2] which transmit only ultra-violet, violet, blue, green, yellow, red and infra-red rays respectively.

Our results indicate that: (1) The number of germinations is greatest under the infra-red and ultra-violet portions of sunlight and least under the green region. (2) The average height of stalks is greatest in the infra-red and red regions at the one extremity of the solar spectrum and in the violet and ultra-violet portions at the other extremity of the spectrum, and least under the green and heat-absorbing filters. (3) The average weight of plant follows the same sequence as stated with reference to the average height of stalks. (4) The development of chlorophyll is greatest under the green portion of the spectrum and least under the infra-red and ultra-violet radiations.

A comparison of data relative to the quality and quantity of incident energy with the biological effects observed shows that a proportionately small percentage of ultra-violet light (since the ultra-violet content of sunlight is about 10 per cent. only, the visible 15 per cent. and the infra-red 75 per cent.) is as efficacious as the infra-red rays, if not more so, in stimulating and promoting germination and growth.

These observations are substantiated further by the results obtained by Sheard and Johnson on the

[2] Corning Glass Company 586 A, 586 A.W., 585, 584 J, 34 Y, 24, 554 FF and 392 H.

changes in electrical potentials and currents produced in plants by various types of radiant energy. In their experiments it was found that marked changes in potential differences (voltage) were produced by ultra-violet and infra-red radiations and that the electric currents obtained in leaves, when an external but constant electromotive force was impressed, were increased by both these types of radiant energy. Furthermore, these changes in potential differences between the base and the tip of leaves were found to be associated very definitely with the phenomenon of growth. No changes in potential differences or in electric currents were produced by the visible portions of sunlight or various artificial sources of radiation.

The development of chlorophyll is dependent chiefly on the quality of the incident radiant energy, namely, the energy in the green region of the visible spectrum. Little chlorophyll is found in plants grown under filters which transmit infra-red or ultra-violet rays only. A comparison of the energy of the incident light transmitted by these filters and measured with thermopiles shows that a transmission of 5 per cent. of the green region (through a green filter) produces a greater amount of chlorophyll for each gram of plant than is produced by a transmission of 40 per cent. of energy in the yellow or red regions of solar radiation obtained through yellow and red filters.

Conclusions

(1) The ultra-violet and infra-red portions of sunlight are stimulating to germination and enhance growth and development.

(2) The green portion of the solar spectrum, which is its region of maximal energy, is inhibitory to the processes of germination and growth.

(3) The development of chlorophyll is enhanced under the yellowish-green, green and greenish-blue regions of the spectrum.

(4) The least development of chlorophyll occurs under the ultra-violet and infra-red portions of the spectrum.

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SOME PRACTICAL RESULTS OF AN X-RAY ANALYSIS OF COTTON FIBERS

While it has been known for some time that cotton fibers yield a typical cellulose X-ray diffraction pattern, comparatively little work has been done with this material. The explanation of this lies in the fact that in ramie fibers, for example, there is a much more perfect orientation of the colloidal micelles parallel to the fiber axis than is true in cotton, which appears to have a spiral arrangement. Ramie fibers have, therefore, been practically exclusively used in the brilliant X-ray work which has led to a final analysis of the crystalline part of cellulose. It is now definitely known that cellulose belongs to the monoclinic system and that the unit cell dimensions derived from X-ray patterns are: $a = 8.3$, $b = 7.9$, $c = 10.3$ A.U. The last named is the identity period along the fiber axis, with a monoclinic angle $\beta = 84°$. This small unit cell contains four $C_6H_{10}O_5$ groups. It has been further demonstrated that cellulose is built from long primary valence chains of the dehydrated glucose molecules and that a bundle of these long chains constitutes the colloid micelle or crystal grain. The measurement of the breadth of the X-ray diffraction interferences has proved that in various samples the length of the micelles, which is the same as the length of the primary valence chains, lies between 150 and 500 A.U., and that the cross-section dimension of the micelle, which is determined by the number of chains in a bundle, lies between 20 and 50 A.U.

It is this complete structure of cellulose which enables explanation of the physical and chemical properties of cellulose fibers. Up to the present time all the X-ray work has been devoted to fundamental studies of cellulose and practically nothing has been done in the practical sense of following growth or in classifying fibers of a particular kind. In the X-ray laboratory of the University of Illinois extensive independent and cooperative studies are in progress on wood and on cotton fibers. The first results in comparative studies of cotton fibers have been so promising and have so far exceeded the expectations that it has seemed wise to report in a preliminary note these findings on structural changes during growth and on classification of mature fibers.

A series of developmental stages of the fibers of *Gossypium hirsutum* representing growth intervals of eighteen, twenty-one, thirty-five and fifty days respectively have been studied thus far, by means of the diffraction method, utilizing the copper Kα radiation, the pinhold method and a bundle of parallel fibers as the specimen. The eighteen- and twenty-one-day samples represent the period of elongation in fiber growth. The thirty-five-day sample represents the early stages of wall thickening and the fifty-day sample the mature fiber at the close of its period of wall formation. The diffraction patterns for the four samples show a remarkable progression. In all cases the patterns indicate a crystalline condition which, however, is progressively more perfect with age. The eighteen-day sample pattern is distinguished by very broad and continuous rings indicating random orientation. The principal diffraction ring has a diameter of 4.05 cm. There is no evidence whatsoever of true fibering. The twenty-one-day sample pattern also shows continuous diffraction rings but these are sharper, indicating larger micellar size, that is, longer chains, and the diameter of the principal diffraction ring is 4.25 cm. The thirty-five-day sample pattern shows for the first time definite evidences of preferred orientation as indicated by greater intensity of the diffraction rings on the equator as compared with the poles of the pattern. The fibering, however, is still imperfect. The diameter of the principal diffraction ring is 4.50 cm. Finally, in the mature fifty-day fiber the pattern indicates the maximum degree of preferred orientation, the sharpest and narrowest diffraction maxima, indicating the final size of the micelles and a diameter of the principal diffraction ring of 4.60 cm. There has been thus a progression in these samples in fibering, in micellar size indicated by diffraction breadth and in the actual crystal unit cell dimensions as indicated by the interference ring diameters. The dimensions are largest for the youngest sample. This seems to indicate, therefore, a condition of intra-micellar swelling or of the fact that the primary valence chains are not oriented within the colloidal particle in a perfectly parallel fashion. It may also mean that the crystalline substance is not yet true cellulose. As the sample ages the diffraction ring increases in diameter, which means that the unit cell dimensions decrease until in the mature fiber the dimensions for ordinary cellulose are reached. It is evident that preferred orientation occurs some time between the twenty-first and thirty-fifth day, probably quite sharply. Further tests are now being made with samples showing finer gradation in growth.

Another series of samples of mature cotton fibers showing markedly different physical properties has been subjected to X-ray analysis and here again the diffraction patterns are equally striking in their differences. The samples consisted of a cotton of high quality, one whose fiber quality had apparently been lowered by adverse developmental conditions and a third which represented an inferior variety. In all three cases the diffraction rings have exactly the same measurements corresponding to true cellulose. The differences lie, first, in the degree of preferred orientation, and secondly, in the sharpness of the interference maxima. There is a marked difference in the degree of fibering which is maximum in the case of the first sample and minimum in the third. For example, the cords of the arcs on the diffraction rings produced by fibering have the following lengths: first, 2.8 cm; second, 3.25 cm; third, 3.8 cm. This gradation is exactly the same as that displayed by the qualitative differentiation. Furthermore, an examination of the sharpness of interferences indicates that the chain lengths in the colloidal micelles are greatest in the first sample and least in the third. Therefore, satisfactory physical properties are unquestionably connected with colloidal size greater than a critical value and in the best possible arrangement of these micelles with respect to the fiber axis itself. While these samples represent perhaps extreme conditions it seems very probable that it will be possible to classify cotton within much narrower limits and that the X-ray method will, therefore, prove an indispensable new tool both for specification and research in the cotton industry. A continuation of these studies in a quantitative manner is in progress.

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THE SCIENTIFIC VERSUS THE PHILOSOPHIC APPROACH TO THE NOVEL PROBLEM[1]

By Professor TRUMAN L. KELLEY

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It has been common to differentiate between science and philosophy, crediting the former with reliance upon facts and a kinship with data and the latter with a trust in logic and an affinity for the pure and ethereal verities of the mind. The expression "science proves" carries a very different connotation from "philosophy establishes." If it is held that "science proves" by a sound process, but one that is different from a second sound process whereby "philosophy establishes," I assert that the contention is wrong. The thesis of this paper is that there is but one method tending to establish truth in the world of phenomena. This issue can be reduced to that of the places of data and of judgment in reaching decisions in the ordinary affairs of life. I believe you will all agree that if "science proves" data certainly are involved, and if "philosophy establishes" certainly there is a mind at work, but neither data nor the mind can operate alone. To draw a crude, though, I trust, not inaccurate parallel, we can say that life in the biological sense is the interaction of the atmosphere with the soil. Call the soil "data," the atmosphere "mind," then life is "fruitful thought"—the interaction of the two. Dust does not burgeon upon the surface of the moon or even fly into tornadoes, for there is no wind to stir it, and an atmosphere does not swirl in space where there is no dust or other gravitational field to hold it. We can not think without facts, even though we may have facts without thinking. No person or organization can operate without data, *i.e.*, phenomena of life which are at least to a degree measurable and verifiable.

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[1] Address of the retiring vice-president of Section Q—Education, American Association for the Advancement of Science, December, 1929. A part of this address in modified form was first given before Phi Delta Kappa, New York, 1929.

Of course, I can not prove that the soil on the moon does not burst into bloom, much as I may believe it. The scientific accuracy of that statement is not the point, so grant it for the sake of the illustration. Therefore let us investigate in greater detail the part data or measurable items of knowledge play in careful thinking. Any statistic or objective measurement which fits into any classification scheme whatever, *i.e.*, has meaning, is such a bit of systematized knowledge. In addition to this there are novel items, meaningless at the initial moment, but quickly given meaning by the interpreting mind, in short, their novelty disappears and they present themselves as systematized knowledge. Starting with the novel element in an experience we find it quickly taking on the common feature, or statistic, characteristic. Now let us start with the statistic and see if it migrates, in the mind that apprehends it, toward the novel. The objective measurement once gotten is used, and the specific way in which it is used is the matter of importance to us.

Let me picture a situation in which the measurement has apparently taken the place of judgment in order to raise the question of the place of judgment on the one hand and of the measurement upon the other. The activities of the train dispatcher serve our purpose. He receives over the wire information as to the place and rate of movement of the various trains operating within his division. Two trains moving in opposite directions upon a single track would crash did he not heed the objective measures reported to him and see that one train takes a siding. If the expected communication is slow in coming in he must literally long for it, and when it does come grasp it with joy and confidence. There is no trace of rivalry between his judgment and the facts upon which it operates, though these are so potent in the mind of the train dispatcher that they may be said to dominate the situation. This is so because the executive, by a full and free exercise of judgment, *wills* to heed and trust the objective measure. Such importance as it has, has been given to it by an act of judgment based upon earlier experience adequately scrutinized with very similar measures. Thus we are dealing with a scientific conclusion—one impregnated with human judgment and not devoid of it. Because of this science can never be exact, because it is never free of the element of human appraisal.

Let us carry this thought over into school life. A third-grade child is given an ABC reading test and secures a score of 40 on it. It is also known that the average score on this test for all pupils of the third grade in which this child is located is 30 and that the average for the fourth grade is 40. What will the school executive do in this situation? Promote the child one term, promote him two terms, keep him where he is or demote him? The mere figures that I have given do not answer the question. Surely it is inconceivable that the few facts given, unsupplemented by important other facts and unoperated upon by human judgment, do adequately answer a question of promotion. They can not in themselves be sufficient, and teachers and principals should so affirm. Such objective facts should affect a teacher's or principal's judgment, which is the ultimate arbiter, only in so far as the teacher or principal asserts it reasonable that they should. There are a number of things that should operate in the building up of a conviction of trust or distrust of the ABC reading test scores. First, is the agreement, in one's experience, between the test scores and ability of pupils as otherwise ascertained. Second—as pertinent to the individual case—is any accessory information about the pupil that may be available. Third, is the confidence one places in the sponsors and critics of the test (authors and others). And fourth, and ordinarily by far the least important, is the confidence one places in the test as a result of a perusal of the test items. As a result of these investigations one gives little or great heed to the test score.

The point is that it is the executive that *gives* to the score such importance as it has. If, in his best judgment, based upon all the facts that he has been able to muster, the test is not entitled to an important position in determining promotion, then, in the executive channel that determines promotion, it does not and it should not hold an important position. Perhaps some of you disagree with my statement that under these conditions the test "should not" hold an important place. You may say, "Suppose the test is intrinsically an excellent one, then it should hold a high position even though the executive is unaware of its genuine merit." I disagree with this view, for the executive should be the responsible party in the matter and personally held to account for any mistakes. We may hope that it will always be impossible to shift the onus of poor classification to so inanimate a thing as a score on a test.

Unless the executive looks upon the test score as a friendly and serviceable item of information for his own understanding of the child he should not use it. If you are a teacher and learn that little Bessie Jones has weak eyes you will place her in a favorable seat. You are glad that you have this information. As a result of it you and Bessie are better friends—you a better teacher and she a better pupil. The measure of Bessie's eyesight is a friendly fact because you know its implications and it does not mislead you.

Test scores which do not mislead hold the same possibility, making for mutual understanding and friendship between teacher and pupil.

It has been my pleasant duty to test many children. Time and again I have had before me scores for some child upon tests in which I knew from long experience a certain confidence could be placed, and I have literally longed to meet the child in person. Trusting the test scores, not implicitly but to a degree, I felt that I already knew the child, that he was a friend of mine, and I wanted to know him still better—to know wherein the tests had not been quite fair to him and still more to know those reaches of his character about which the test scores had been annoyingly silent.

Treated in this manner the test score is never a substitute for judgment. It is merely an aid in making judgments. It never delimits character, capacity or achievement. It merely helps in the understanding of certain limited portions of these things. It should never circumscribe one's field of effort to understand. While illuminating a limited field it should challenge one to explore the reaches of mental life that stretch beyond.

Suppose a man possesses a small rowboat enabling him to explore the ocean throughout a radius of twenty miles. This does not decrease his knowledge of the ocean entire. On the contrary, it challenges him to get a ship and move out further and to listen to what travelers have to say and to appraise their tales with a sounder judgment. Just so should the information given by one good achievement or mental test enrich one's consciousness of and interest in the subject's life entire.

Certain opponents of objective mental measures assert that tests have a deadening influence upon the curriculum by tending to limit teaching to the narrow fields represented by the tests themselves. This may be so if one becomes so enamored of the test that he loses sight of the child tested. I fear there are such people. I would criticize them, not the instrument they use. In an earlier generation such people were fetish worshipers. Some talisman, some rabbit's foot, some hocus-pocus answered every need. If a storm arose at sea, abracadabra stilled the waters; if a child was sick, abracadabra allayed the fever; if a male heir was desired, abracadabra turned the trick. So to-day, in a somewhat refined manner, we find the believers in the alpha-omega omnibus test. It tells what is good for backward babies; it clears the fevered brow of the dean when the rough-house rowdies walk the carpet; it sheds a great white light when college recommendations are called for, and it does a score of other things as well. You can pick out the modern measurement fetisher by the multitude of widely different things which the test of his choice will do for him.

If a test is in truth a good test it is good for something, not everything. Do we find in any other field of scientific endeavor an instrument that is good for everything? Thermometers measure temperature, barometers pressure, ammeters electrical current, and so it goes. As a thermometer an ammeter is a total failure.

I believe that we should approach any mental measure devised with the idea that its field of utility is limited, but I would be the last to attempt to limit the field by *a priori* considerations. We must by careful trial determine the limits of utility. If we find that they are broad let us keep the instrument with its broad implications. This is not fetish worship—it is knowledge. My criticism is of those who extend the field of application without knowledge. It should be obvious to every one that, as with every other scientific instrument, the judicious use of a test is something achieved only after careful study and much experience. Be confident that the process can not be shortened. Recently a student registered in my beginning class in measurement called me to task for dealing with averages, medians, age and grade norms when all she wanted was to know how to use tests in vocational counseling.

Though my remarks suggest a limit to the field of utility of objective measures I hope they also show the reality of the value of such measures. The score of an individual does not operate of its own accord, but only *via* the mind of an executive who concludes that the case in question properly falls in the class wherein such scores are useful. I have taken much time to make this point, but I believe it is fundamental and, unfortunately, sometimes overlooked. No matter how well fortified by a long past history a certain type of measurement may be, it must take on the characteristics of a novel event in order to be properly interpreted in a new situation. The breadth of view and caution demanded of the test devotee is of the same order as that demanded of any scientist working with specialized measurements of any sort.

To generalize: It matters not whether we think of the interpreting individual as viewing all the elements in the case as novel or as viewing all the elements as lying within his organized knowledge. Whatever the view, the so-called novel or the so-called old elements all call for the same critical appraisal. If the elements felt to be novel are not subsumed under some existing-in-the-mind system, terror, or the taking-a-chance type of decision, results, and if the elements felt to be old are subsumed under an old system without a new and specific vindicating judgment there results a decision characterized by formality and lack of adaptability. The adequate mental process, whether that of philosopher or of scientist, scrutinizes the felt old and the felt new as though each were both old and new.

Ordinarily a decision, though made in the light of an executive's entire experience, must be promptly made and can not wait to be verified by a time-consuming study. Herein we may look for a difference between the philosophic and the scientific mental process. I will quote the distinction that Dr. Kilpatrick draws in this connection.[2] He states that science ordinarily postulates the question, "If I do this what will happen," but that philosophy can not wait to see what will happen. He says, "Philosophy in contrast faces a situation of necessary action. . . . Note that any situation confronting is actual and must be met, and that any choice or course whatever, including refusal to act, is *an* answer which carries with it its appropriate harvest of consequences. Philosophy then asks, 'In the light of all this what shall I do?' " I believe that Dr. Kilpatrick has here stated *the* essential difference between science and philosophy—other differences follow therefrom. Philosophy is willing to attack any problem, any time, anywhere, and give an immediate answer. Science is not. I would not cite this as to the credit of either the one or the other, but do cite it with Kilpatrick and Dewey[3] as a difference of great moment.

The philosophic question, "In the light of all this what shall I do?" may be paraphrased without inaccuracy as, "In the ignorance as to consequences that enshrouds me, what shall I do?" for, of course, the "appropriate harvest" is not known at the time the decision and resulting act is made. The philosophic answer to an issue is, "Do something and the best you can," while the scientific answer is, "If in doubt delay decision and investigate." Each procedure has its place in this life, this hurly-burly in infinite time. It is something of a travesty upon the mind of man that it is philosophy, sometimes thought of as the enduring, that responds to the hurly-burly, and it is science, changing science, that seeks to be judged by the standards of the permanent. Let us note some of the consequences of these outlooks.

The scientist procrastinates decisions, is other worldly, is of little aid in time of stress. He functions where deliberation and experimentation are possible, and his method is that of experimental analysis, synthesis and verification. On the other hand, the philosopher provides an almost immediate solution. He counsels in times of stress and rides every emergency. His method is that of inadequate analysis, because logical only and not experimental, and inadequate, but much synthesis. Knowing that he has a unique situation to deal with he makes much of "integrations" and "total situations." His total picture, to which he reacts, may be grossly at variance with the real[4] total situation present, but of this he knows nothing because no experimental synthesis of factors has been made.

The statement that[5] "the [philosophical] effort is, as far as may be possible, to find a course of action which will save all the interests, which will integrate all into one course of action that best saves all" is also an excellent statement of the purpose of multiple correlation and of any scientific attempt to explain total outcomes. Though science moves more slowly and with greater assurance here, not being free to synthesize except as experimentation gives warrant, still it moves with the same purpose as does philosophy. In connection with this issue Dr. Kilpatrick implies that science deals only with parts of situations, while philosophy deals with them entire. Now there is no logic that deals with wholes as wholes. If a problem case involving a cross-eyed, untrustworthy, brilliant, crippled, butcher's boy presents itself, what technique can treat this as a whole and without analysis? A logical or experimental analysis must be incorporated in any reasonable attempt to arrive at a solution of the total problem. How will you ever get the case referred to the oculist and how, unless there is analysis, will you ever get the cooperation of the father unless you call upon the butcher, etc.? Philosophy at its best must involve very detailed logical analysis followed by equally careful synthesis. As practiced, and, one would think, even advocated by Dr. Bode[6] in his recent work "Conflicting Psychologies of Learning," the chief emphasis should be upon synthesis. Now experimental science, or that which involves the checking of an hypothesis against an outcome, depends upon analysis as a major feature in the process of arriving at the truth. Why is there a short-circuiting of this step in the philosophic approach? Perhaps a parable is in order.

There was once a very wise man who put a cat in a box with mice outside, and every time the cat scratched its ear, lo and behold, the box opened, the cat jumped out, and the one mouse caught tasted good. As time went on the ear-scratch movement decreased, almost to the vanishing point, but the jump through the door continued to be followed by some plaintive squeak, "The brave cat caught me." The sad part of the tale is that the cat never learned that the wise man had so fixed things that in general the more efficient the ear scratch the bigger the mouse caught, for any squeak nearly convulsed him with joy.

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[2] W. H. Kilpatrick, "The Relations of Philosophy and Science in the Study of Education," *School and Society*, 30: 39–48, July 13, 1929.

[3] See Kilpatrick, *loc. cit.*

[4] Meaning, of course, not some "thing in itself," but a thing as conceived to exist after very careful study. "Reality" in an ultimate sense can have no scientific, *i.e.*, verifiable, meaning.

[5] Kilpatrick, *loc. cit.*

[6] Boyd H. Bode, "Conflicting Psychologies of Learning," p. 231, 1929.

Is philosophy satisfied with any outcome? Dr. Kilpatrick[7] thinks not, but upon this point I fail to follow him. He writes: "having answered, philosophy awaits the outcome to test the validity of its answer as truly as does science." How can philosophy await the outcome as truly as does science? The philosophical act must be terminated at some time, just as must the scientific, and, as previously pointed out, philosophy can not wait—no, its act is terminated when conduct commences. Let me give a case which might easily have grown out of the philosophy of but a few generations ago. Suppose that philosophy concludes that bleeding is good for anemia, a vein is cut and the patient dies, then surely philosophy is to be charged with the death. No spiritual apology will convince a regretful wraith that the philosophic act is still in process. True, had the case been given to science she might have shirked the task, pleaded ignorance and kept her hands off and said, "Let philosophy have the credit." While admitting this penchant of science to procrastinate, still, when a judgment, whether scientific or philosophical, is passed resulting in decisive conduct the problem as originally set is terminated. I must conclude that philosophy does not await outcomes—it acts—whereas science does await the outcomes of its experimental set-ups before it acts in the non-experimental, or important, life situation. If we run through the steps in the complete act of thought, much as given by John Dewey,[8] except that I have added a final step, number 8, we can clearly locate a difference between philosophic and scientific thinking. The steps are:

1. A felt difficulty.
2. A definition of the difficulty.
3. A tentative solution.
4. A mental elaboration of the solution, leading to
    a. Additional tentative solutions and elaborations, if felt necessary, finally leading to
5. The belief that the solution is all right.
6. An experimental verification.
7. An appraisal of the experimental findings leading to acceptance of mental solution and a decision for immediate conduct, or to rejection and a reinstatement of a felt difficulty. The process is continued until a verified solution which is immediately serviceable is obtained.
8. A forward look, or mental picturing of future situations to which the present solution is pertinent.

The first five steps are common to philosophy and science, but the sixth step, experimental verification, requires appreciable time not available to one who must act. Science continues and carries through the complete act of thought; philosophy does not. The distinction here made is reflected in the difference in activity of acknowledged scientists and philosophers. A distinction which I have occasionally heard calling the thinking part of the scientist's endeavors philosophic and the measurement and manipulative aspects scientific is a distinction that would not occur to or appeal to a scientist, as it would chop him up into unrecognizable parts. There are three important consequences of the difference noted. The philosophic solution is timely no matter how urgent the problem; the philosophic solution is more likely to be wrong than the scientific, and third, the philosophic forward look should be one of misgiving and largely a query.

My mind reverts to the sad parable of the cat. To the philosopher any outcome of his cerebration suffices. There is no conceivable method of determining the real excellence of a proposed course of action in a novel situation at the time it is first proposed. The pragmatic test is how it actually works out, but by the time this test is made the solution given by philosophy is long past. We seem to have reached the conclusion that the only solution to the urgent novel problem is the philosophic one, and that it is no solution because its fitness is and must remain unknown until it is too late to alter it, *i.e.*, until consequences, good or evil, have actually followed. In the strictly logical sense that every present moment is a novel one and that something immediately takes place in reaching the next moment, I believe that this is true, but do not draw the important conclusion that therefore, in immediate problems, we should not turn to science, but resign ourselves to the unverified speculations of philosophy.

That these are unverified Dr. Bode appreciates, for he says,[9] "The more we emphasize man's power to shape his own destiny, the more necessary it becomes to recognize the possibility that he will make a mess of it." Though he realizes this his only comfort is philosophy, for he writes:

> In any event the problem [of whither we are headed] calls for an interpretation and organization of values, which is not a problem for scientific research, but a problem of philosophy. It is not a problem for science because it is not a problem that lends itself to the application of scientific technique. The scientist has his own special devices for collecting and interpreting data, but these devices prove inadequate when the situation calls for a recreating or reinterpreting of old values and old ideals. . . . If the foregoing discussion is correct, then

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[7] Kilpatrick, *loc. cit.*

[8] "How We Think," 1909.

[9] Bode, *op. cit.*, p. 300.

most of the industry called the "scientific determination of objectives" is on a par with catching birds by putting salt on their tails.

With this I utterly disagree, for the problem of our educational and social ideals is not a problem that must be solved upon the moment. If so solved it would be unsatisfactory even to the philosopher, for to-morrow brings another moment. Far better that a year, a decade, in some matters a generation, be spent in determining educational and social objectives and techniques found by trial to be in line with past progress than that we "settle" the problem by speculation. If one asserts that what constitutes "past progress" is beyond comprehension he is indeed a pitiable optimist if he nevertheless believes that he can define "future progress." We can not settle the problem of objectives for long by any method, but the ten-year experimental study holds promise of fitness and permanence not to be expected in the cloistered solution. Philosophically every moment is novel and calls for a new interpretation. Practically, every moment is surcharged with physical and emotional settings that have sprung from the past and that have been characteristic of innumerable past situations. The novelty of the moment, though real, may be insignificant in importance in comparison with the non-novel elements that are present. One of the features of the moment is the novelty in the organization of non-novel elements. From the view-point of the gestalter this dominates the situation. This is just a point of view and a very unhappy one, for it can never be proved, for, according to hypothesis, no two situations are alike, and accordingly a testing out and verification is never possible. The scientific point of view is to look upon the novel situation as characterized by certain cue or critical elements, or critical combinations of elements, which can be reinstated. The beauty of this view is that it can be proved right or wrong, as the case may be, by trial. This view-point has engendered mighty advance in the physical and biological sciences, and surely psychological and social advance lies in the same direction, for only thus is verification of progress possible.

I have made no distinction between science and philosophy on the basis of remote purpose or outlook and of course subscribe to the idea that a mind-body dualism is not necessary to a scientific point of view, and also to the idea that there is great need of and value in a criticism of historic conceptions. Dr. Kilpatrick considers that[10] "the need for the continual criticism of current thought assumptions in the light of their wider bearings would of itself, apart from all other considerations, suffice to give to philosophizing a permanent place among the higher services of thought to man." The stimulus to evolution consequent to this service can hardly be overestimated, but is it not above all a service rendered by science? From Roger Bacon to Einstein the great cues to a criticism of current thought assumptions have come from science. Philosophy has tagged along and consolidated these scientific salients, but she has not made them. Did the score of philosophical interpretations of relativity precede or follow the experimental findings? Of course they followed. Did the philosophy of Bertrand Russell instigate companionate marriage or did popular interest in it raise an issue that he attempted to place in a rational understanding of mankind? Undoubtedly it was this latter, and so it goes. The intense and keen, but orbital arguments of the middle ages illustrate the value of a criticism of current thought assumptions not leavened by new scientific facts. That science should be the leader in this is inherent in the process of science, for when the verification step of experimental science fails to yield a check with hypothesis there is, practically speaking, an inevitable reexamination of the premises, which of course are merely current thought assumptions. There is no comparable cue stimulating the questioning of assumptions in philosophy. The jolt that sets off the questioning process is from the outside—it is unanticipated experience.

My advocacy of experimental investigation in the attack upon problems of social value is because of the method of science, not because it is exact. There is no "exact science." A definition of science not permitting of error both in the data and in the judgments of human beings who interpret scientific facts is of no practical use. While upon this matter of error we may say that it is scientific to know that there are different degrees of exactness inherent in different stages of an argument. Science recognizes this time and again when philosophy (as practiced) ignores it. Having discarded any thought of exactness in science we can then turn to the important idea of the reliability of measures, findings and judgments. Philosophy has been slow, to its detriment, in following science in this. Until philosophy attaches probable errors to its concepts it will fall far short of its possibilities. In recent generations it has willingly accepted the findings of its younger brother, science, but it should go further and adopt concepts of methodology from it also.

I wonder if there is a conspiracy among philosophers to belittle science and claim its peculiar merit for themselves. Whitehead writes,[11] "There will be some fundamental assumptions which adherents of all the variant systems within the epoch unconsciously presuppose. Such assumptions appear so obvious that people do not know what they are assuming because no other way of putting things has ever occurred to them." Again, "A civilization which can not break through its current abstractions is doomed to sterility after a very limited period of progress." I take these words, not as Whitehead meant them, but as a fine argument for science. To discover errors it only requires that experimental setups involving hypotheses based upon these unknown errors be attempted. Then as the attempt fails the error is revealed.

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[10] Kilpatrick, *loc. cit.*

[11] Quoted from Dr. Kilpatrick's article. A. N. Whitehead, "Science and the Modern World," pp. 69 and 82, 1925.

To what fields must science be limited? Specifically, should some one say that education is outside the pale, would he also say the same of law, sociology, economics, psychology, biology, geology, chemistry and physics? The relationships of physics and those of man to man are of the same order in consciousness. I can not see how one can deny dualism and still draw a line in the list just given separating the scientific from the non-scientific. If one draws no line and concludes that physics can never become a science (a little surprise for the physicists) I for one shall agree, in the sense that as far in the future as the mind can dimly perceive physical issues will arise for which no scientific answer is available—*i.e.*, no answer experimentally and adequately tested out. In the same sense only do I grant that education can never become a science.

Let us sum up the place of philosophy in life and specifically in education. It seems to hold an actual position which I deem to be different from its legitimate one, so let me speak of its actual position first. I will illustrate by reference to a field with which I am familiar—that of test construction. An author devises a test of honesty, let us say. He philosophizes most armchairishly, not failing to consider the experimental evidence reported upon earlier tests having something to do with honesty. He counts his hour or two (or ten or twenty, if you like) of armchair agitation as high grade and adequate for the solution of the issues. So he publishes his original contribution for the use of an expectant world that will no longer wait. True, it may be only that fraction of the world represented by the author that will no longer wait. However, this inability to wait is definitely a part of the philosophical attitude that never matures into the scientific attitude. The decision by the author that his exercises test honesty has been reached by speculation in lieu of investigation. Here philosophy is merely a makeshift, quite unnecessary, for science. This is my lesser criticism of it.

If there is necessity for prompt action any sort of a shift is welcome, so it is not disparaging to say that philosophy is the best method for the expeditious selection of makeshifts. Surely, excepting habitual acts, the majority of the acts of life will fall in this class.

My major criticism is that the test author, having made his speculations and come to his final conclusions, feels very contented with himself—he thinks he has done something worth while and of lasting value. Unfortunately, as he writes fully and with utter sincerity, many of his readers think so too, and thus they also are content and may so remain for years if they attempt no experimental verification of the test. Philosophy is here the great narcotic, the soothing-syrup for author and readers, when in truth a gadfly is needed. It has played this rôle throughout history and it does so to-day.

What is the merit of the philosophical conclusion? Because it is a makeshift it has a place—just the important and unavoidable place of the expedient. Think of a forty-niner in his rush to the gold fields of California in his eastern Conestoga wagon, and suppose that he break a whiffletree out in the Nevada desert. If he is the kind of a man who will not use a makeshift and sends back for a new whiffletree, he might by some be called a scientist—I would use a less complimentary term. Whatever he is called would not apply for long, for he would soon be a scrap of dried bones. In this case the solution will not wait. The time necessary to carry out the complete act of thought, with its step of experimental verification, is not present. Something must be done promptly, and when done it may be called a philosophic solution. This does not state that it is a "right" solution, or even a serviceable one. If the forty-niner tries to mend his whiffletree with a piece of yucca he will probably waste time and increase his danger. If he break up his wagon seat and use the timber he may pull through. Whatever he does has one indubitable merit—that of promptness. There is no certain merit in it on the basis of long-time adequacy. This is characteristic of every philosophic solution. The scientific solution is, or rather aims to be, a more or less permanent solution. The philosophic solution frequently should not even aim to be this, for when such is aimed at there is commonly time for the try-out step, so that experimental verification can enter in and the solution become scientific.

Problems demanding immediate answers, or at least answers before adequate investigations can be made, will always be with us. We shall always need philosophy. There can be no issue here. Not only so—we are going to need it increasingly in the future. If the area of a small circle represents scientific knowledge its periphery may well represent unsolved issues which, when first met, will ordinarily demand a philosophic solution. With the increase of this circle as science advances goes an increase in the periphery. I neither hope nor look for a decrease in philosophy as science advances, but just the reverse.

We shall need more and above all better philosophy. It seems to me that the most adequate philosopher will have the following characteristics. He will be a man of wide culture, familiar with the arts and sciences, with the psychology of man and with the values of life. He will be an accurate thinker—a sound logician—and have an extensive acquaintance with the facts and the methods of science. There is a peculiar necessity that he be aware of the scientific method. This method aims to secure more permanent solutions to its problems than does any other. It accepts the fact that time and investigation are necessary to this end. Though philosophy acts where these things are impossible the philosopher should attempt to parallel in his thinking what the experimentalist does in fact—only so can there be a tolerably promising philosophic solution of the problem.

Let me illustrate this by a problem which arose during the war. It was necessary to select men for training as officers. It seemed evident that the best selection would depend upon possession by the men of certain traits such as mental ability, physical stamina, moral courage, cooperativeness, leadership, etc. Ratings upon these traits by superior officers of men in camps could be gotten. The problem was how to combine them into single gross ratings which could be used in the actual selection of men. Time prevented an experimental investigation, so philosophizing had to be appealed to. An experimental investigation in which these various trait measures were used to estimate demonstrated success as officers would have yielded the weights that should be attached to the measures separately in order to get the most reliable aggregate measures of fitness as officer material. In short, the experimental treatment would have analyzed the data and then combined the separate trait scores into the most meaningful total ability scores. The concepts of total correlation and of partial correlation (not of course assuming any limited type of relationship, as that of linearity, between measures) here operate and they alone do operate. No logical treatment not paralleling this can be as adequate as one which does parallel it. The more completely the philosopher parallels in his thinking the analysis and synthesis which the experimental treatment would yield the better is his philosophical solution. The great endeavor of the philosopher here should be to ape mentally the steps of science. He can not have a technique which is better (omitting the time factor) than the scientific technique. Just the moment that he demonstrably did have science would claim it as its own, for true science has no fetishes that it clings to in the face of evidence.

CONTRIBUTIONS TO PHYTOPHARMACOLOGY OR THE APPLICATIONS OF PLANT PHYSIOLOGY TO MEDICAL PROBLEMS[1]

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INTRODUCTORY

As early as 1921, while studying general laws underlying physiological and pharmacological reactions, the author conceived the idea of making a comparative study of the action of various drugs on living plant protoplasm in contrast to animal protoplasm. The study of pharmacology, as carried on in our medical schools and research institutions, concerns itself almost exclusively with the effects of drugs and poisons on animals and, strictly speaking, is zoopharmacology, just as the study of physiology in the same institutions is confined exclusively to the physiological functions of animals, or zoophysiology. There is, however, a very important department of biology dealing with plant physiology, to which the name of phytophysiology is sometimes applied, and the writer was curious to inquire into the effects of drugs and poisons on living plants and in this way developed a new department of biology, to which the term *phytopharmacology* might be applied. These studies were begun with an examination of a number of alkaloids, the most interesting of which happened to be cocaine, and the findings in connection with a study of this substance were of such importance that they were followed by other studies along novel and unexpected lines of experimentation, resulting in important discoveries not only of purely scientific value but also of practical worth to pathology, medical diagnosis and therapeutics.

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[1] Read before Section N—Medical Sciences, of the American Association for the Advancement of Science, at the Des Moines meeting, January 1, 1930.

The effects of drugs and poisons on plant tissues may be studied in various ways. The author and his associates have investigated the effects of various substances on the germination of seeds, on the growth of roots and stems, on the influence exerted on flowers, the effects on geotropism, on transpiration and respiration, the effect on yeast and fungi, on chloroblasts, on protoplasmic streaming, etc. It was soon found that a most useful and profitable method of making such phytopharmacological studies was the employment of seedlings of *Lupinus albus* and observations on the growth of their roots and stems in normal plant-physiological solutions, on the one hand, and on solutions of various drugs and poisons in the same kind of plant-physiological solutions, on the other hand. In this way the author has developed a quantitative method of studying the phytopharmacological and phytotoxic effects of various chemicals which proved to be of great usefulness.

STUDIES ON COCAINE

It is well known that the cocaine molecule can be easily split by hydrolysis into three components, a complicated nitrogenous base known as ecgonin, a molecule of benzoic acid and a molecule of methyl alcohol. In previous studies, carried on by Macht and various collaborators, the pharmacological effects of cocaine, as such, and other products of decomposition on various animal and animal tissues have been investigated, and it was found that the alkaloid cocaine is very much more toxic for animal protoplasm than the products of its decomposition are.[2, 3] A study, by Macht and Marguerite Livingston, of cocaine and of ecgonin, sodium benzoate and methyl alcohol, individually and in combinations, on living plant protoplasm revealed that whereas the alkaloid cocaine is extremely toxic for animal protoplasm, it is comparatively little toxic for plant protoplasm, as much as 2 per cent. cocaine or more being required to inhibit the growth of *Lupinus albus* roots completely. On the other hand, while sodium benzoate, one of the products of cocaine hydrolysis, is practically non-toxic for animal tissues, it was found to be extremely toxic for living plant protoplasm, as little as 0.007 per cent. completely killing the seedlings of the same plant.[4]

These findings, interesting in themselves, revealed that plants may be much more sensitive to certain drugs than animal protoplasm may be to the same drugs, and suggested the idea of employing plant-physiological methods for the detection and study of certain toxic substances not demonstrable by ordinary zoopharmacological or zoophysiological methods. The first extensive study on this subject was carried on by Macht and Lubin in connection with the poison of menstruation.

STUDIES ON MENOTOXIN

The authors undertook to investigate scientifically by experimental methods, accurately controlled, the old belief in regard to contagion of menstruating women. Studies were made with the serum of women during menstrual and intermenstrual periods, and it was clearly demonstrated by phytopharmacological methods that such blood serum contained a toxic substance—"menotoxin"—demonstrable immediately before the onset of catamenia and during its course, which toxin was extremely poisonous for living plant protoplasm. The presence of the same menotoxin was demonstrated by the authors to be not only in the blood serum but also in the saliva, sweat, milk, urine, tears and other secretions during the menstrual period. By means of phytopharmacological experiments, some idea has also been gained in regard to the chemical nature of menotoxin, it being found that it is probably in the nature of an oxycholesterin.[5] Later studies by one of the authors, carried on along the lines of experimental psychology with albino rats in the circular maze, showed that menotoxin affected the behavior of such animals, thus throwing some light on various psychological disturbances frequently encountered in patients at the time of menstruation.[6]

These studies on the poison or toxin of menstruation, while interesting in themselves, from the ethnological, physiological, pharmacological and chemical points of view, led to a still more important discovery, namely, the first demonstration of a toxin in the blood in pernicious anemia.

STUDIES ON PERNICIOUS ANEMIA

While making a routine examination of bloods obtained from clinical laboratories in Johns Hopkins Hospital and elsewhere in connection with his studies on menotoxin, Macht had an opportunity of examining a specimen of blood from a man suffering with pernicious anemia. The serum of this patient was found to be extremely toxic for plants as compared with normal blood serum. Further studies revealed that such a toxic reaction was exhibited by blood specimens from every case of pernicious anemia examined by the author, and furthermore, that such a toxicity was not exhibited by specimens of blood from other blood diseases such as secondary anemias

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[2] Macht and Bloom, *Arch. Internat. Pharmacodynamie et Thérapie*, 25: 379–390, 1920.

[3] Kubota and Macht, *Jour. Pharmacol. and Exper. Therap.*, 13, No. 1: 31–44, 1919.

[4] Macht and Livingston, *Jour. Gen. Physiol.*, 4, No. 5: 573–584, 1922.

[5] Macht and Lubin, *Jour. Pharmacol. and Exper. Therap.*, 22, No. 6: 413–466, 1924.

[6] Macht and Hyndman, *Proc. Soc. Exper. Biol. and Med.*, 22: 208–209, 1925.

from various causes, carcinoma, Hodgkin's disease, hemolytic jaundice, myelogenous and lymphatic leukemias, etc. As a result of such phytopharmacological studies, a contribution was therefore made simultaneously to the etiology of pernicious anemia as well as to the differential diagnosis of that dreadful disease.[7] For a number of years, the author has been carrying on such diagnostic studies in doubtful cases submitted to him by clinicians from various parts of the United States.

These studies on pernicious anemia furnished a quantitative method of evaluating the results of various therapeutic procedures employed in its treatment and have led to the discovery of certain very valuable therapeutic procedures.[8] Thus it was found that transfusion of blood in pernicious anemia patients is of very little value, the toxin being regenerated in a few days. Again, it was found by Macht and his coworkers that the liver treatment of pernicious anemia, while being of great usefulness in restoring the normal blood picture of the patients, does not affect much the quantity of pernicious anemia toxin present in their blood, so that such patients invariably have relapses. To use an expression of a German author, the liver treatment improves the "anemia" but does not destroy, or affect to any great extent, the toxic agent producing the disease.[9] On the other hand, studies carried on by the author, at first in the laboratory with blood sera in quartz tubes and later on patients, have revealed that certain ultra-violet rays greatly diminish and even completely destroy the toxin of pernicious anemia and, as a result of these experiments performed by Macht and Anderson, it was suggested that heliotherapy with ultra-violet rays of wave-lengths 3130 and 2967 Ångström units be employed in the treatment of pernicious anemia, either alone or supplemented by the administration of certain photosensitizing agents and, particularly, of the sodium salt of tetra-bromfluorescein, or eosin. A series of clinical cases carefully studied in this connection has demonstrated the undoubted value of such treatment.[10] Furthermore, the author's findings concerning the toxin of pernicious anemia and the effects of liver treatment have been confirmed by various investigators in Europe.[11, 12]

The author wishes to announce, on the present occasion, a new set of experiments conducted by him in connection with pernicious anemia, namely, on the phytopharmacological effects of spinal fluid. A large number of specimens of human spinal fluid have been examined in order to determine the normal toxicity of such fluids. Study is now being made of spinal fluids from cases of pernicious anemia. Such specimens are rather difficult to obtain, but the observations so far in hand reveal that spinal fluid of pernicious anemia patients is definitely more toxic than normal spinal fluid, and this finding may throw light on the origin of the spinal lesions and symptoms so often encountered in such patients.

STUDIES ON LEPROSY

The author wishes to announce some interesting studies which he has been conducting on the blood sera obtained from leprosy patients. Phytopharmacological examination of such sera, by Macht's methods, on the growth of *Lupinus albus*, has revealed for the first time that such blood sera contain a very powerful toxin, a toxin of even greater potency than that of pernicious anemia. This toxin is quite different from that of pernicious anemia in respect to the effects of ultra-violet rays. Whereas ultra-violet rays destroy the toxin of pernicious anemia, they do not affect, to any appreciable extent, the toxin of leprosy. A comparative study has been carried on by the author on the blood serum of leprosy, on the one hand, and two diseases which simulate it in certain respects, on the other. These diseases are tuberculosis and syphilis. The author wishes to announce in this place the results of these studies. A large series of experiments reveals that the sera of tuberculosis and syphilis are both even less toxic than normal blood serum, whereas the serum of leprosy exhibits an extreme toxicity. Thus, by means of a phytotoxic or phytopharmacological test, it has been our good fortune to contribute to some extent not only to the question of the etiology of leprosy but also to its differential diagnosis from syphilis and tuberculosis (Table I).

In view of the interesting findings obtained by the author in connection with the liver treatment on the blood of pernicious anemia, it was deemed of interest to study phytopharmacologically the effects of certain chemotherapeutic agents on the toxin of leprosy. All these studies were carried on in the author's laboratory on sera of leprosy patients sent to him through the courtesy of medical men in the field, to whom grateful acknowledgment is due. In this connection, the author wishes to make an announcement of certain very interesting findings. Studies were

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[7] Macht, *Jour. Pharmacol. and Exper. Therap.*, 19, No. 1: 461–469, 1926.

[8] Macht, *Jour. Amer. Med. Assoc.*, 89: 753–759, 1927.

[9] Jungmann, *Klinische Wochenschrift*, 7: 441–445, 1928.

[10] Macht and Anderson, *Jour. Pharmacol. and Exper. Therap.*, 34, No. 4: 365–389, 1928.

[11] Tscherkes, *Proc. Soc. Exper. Biol. and Med.*, 26: 869–871, 1929.

[12] Adler, Sinek and Reimann, *Zeitschrift f. Klin. Med.*, 110, No. 3: 309–333, 1929.

TABLE I

COMPARATIVE TABLE OF BLOOD SERA

Kind of blood serum	Average of no. of cases	Phytotoxic index	Effect of ultra-violet irradiation
		Per cent.	
Normal human	100	72	no effect
Menstrual	50	51	more toxic
Pernicious anemia	48	44	detoxification
Pemphigus	18	54	slightly less toxic
Leprosy	22	47	not detoxified
Tuberculosis	27	78	no change
Syphilis	20	81	no change

made on leprosy sera with and without the admixture of dilute solutions of extracts of chaulmoogra oil or its esters, care being taken to make all conceivable controls and checks in regard to the effect of chaulmoogra oil and its esters alone on living plant protoplasm. It was found that chaulmoogra oil and its esters exerted a truly chemotherapeutic detoxifying effect on the toxin of leprosy, whatever it may be. The author is happy to announce, furthermore, that through the courtesy of Professor R. N. Chopra, of the School of Tropical Medicine, Calcutta, India, he examined a series of blood sera from both treated and untreated leprosy patients, and the findings in toxicity in these cases agreed with the laboratory findings in Baltimore. The untreated cases showed the greatest toxicity; the cases treated with chaulmoogra showed a definite decrease in the amount of toxin in their blood, thus clinically confirming the findings made in the author's laboratory. These studies, of course, are of a limited nature but it is hoped that they will lead to further work on the subject (Table II).

TABLE II

CHAULMOOGRA EXPERIMENTS

	Phytotoxic index
I. Leprosy Blood A (India)	Per cent.
1. Serum, 1 per cent., alone in Shive	49
2. Serum, 1 per cent., alone in Shive, irradiated with quartz lamp	45
3. Chaulmoogra ester alone in Shive	73
4. Serum, 1 per cent., plus chaulmoogra ester in Shive	71
II. Leprosy Blood B (America)	
1. Serum, 1 per cent., alone in Shive	58
2. Serum, 1 per cent., alone in Shive, irradiated with quartz lamp	58
3. Chaulmoogra oil alone in Shive	78
4. Serum, 1 per cent., plus chaulmoogra oil in Shive	80
III. Pernicious Anemia Blood	
1. Serum, 1 per cent., alone in Shive	25
2. Serum, 1 per cent., plus chaulmoogra ester in Shive	24
3. Serum, 1 per cent., irradiated with quartz lamp	60

STUDIES IN DERMATOLOGY

The author, in collaboration with Dr. Isaac Pels, a dermatologist, has been examining the phytopharmacological reactions on sera from all kinds of skin diseases, and such a routine study has led to the discovery of another toxin in connection with one more baffling disease, namely, the very grave condition known as pemphigus. Macht and Pels have succeeded in demonstrating the presence of a toxic substance in the blood, as well as in the contents of the bullae, of *pemphigus patients*, which is a contribution to the etiology of this hitherto entirely obscure and misunderstood pathological condition.[13] Studies on other dermatoses are in progress.

STUDIES ON ECLAMPSIA

Eclampsia is one of the gravest pathological complications of pregnancy and puerperium. Various theories concerning its causation have been advanced, the most popular being that which regards it as a toxemia. This theory, however, is not generally accepted because no toxin has hitherto been demonstrable in all the clinical and chemical studies of eclamptic patients that have been made. Even transfusions of eclamptic blood into other animals fail to produce the disease. A new conception regarding eclampsia, which differs from the old toxemia theory, has recently been advanced by Zanggemeister.[14] It was interesting, therefore, to inquire whether a toxin could be demonstrated in eclamptic blood by the newer phytopharmacological methods. Such an investigation has been undertaken by Macht and Losee, and it may be announced in this place that their findings corroborate the newer views concerning the etiology of eclampsia. No toxic substance in the blood serum of eclamptics could be detected by phytopharmacological methods.

ZOOGENIC *versus* PHYTOGENIC POISONS

The experimental investigations described above definitely reveal that certain poisons, or toxins, which could not hitherto be detected by chemical, physical or by zoophysiological and zoopharmacological methods, could be demonstrated by phytopharmacological means and, in general, it has been the experience of Macht and his coworkers that poisons produced by plants, or phytogenic poisons, are more toxic for animals than for plants, while poisons elaborated or produced by animals, or zoogenic poisons, are commonly much more toxic for living plant protoplasm than for living animal tissues. A series of investigations carried on by the writer tends to support this view. Macht has examined a large number of alkaloids, glucosides and other plant products known to be extremely poisonous for animals and found them to be comparatively very little toxic for living plants. On the other hand, he has made studies of various drugs and poisons of animal origin and found them to be extremely toxic for living plants. Thus it has been found that nicotine, atropine, morphine, aconitin, gelsemine, homatropine, lobelin, scopolamin and ouabain, all very powerful poisons for animals, are very little toxic indeed for living seedlings of *Lupinus albus*. On the other hand, studies made with the poison of toads, scorpions, spiders and other animals were found to be extremely toxic for such living seedlings.

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[13] Macht and Pels, *Arch. Dermatol. and Syphilol.*, 19: 640–647, 1929.

[14] Zanggemeister, "Die Lehre der Eklampsie," Leipzig, 1926.

STRIKING EXAMPLES

To illustrate the difference in phytopharmacological reactions between the poisons derived from the plant and animal kingdoms, the following may be appropriately cited. A comparative study of the active principle of the suprarenal gland, known as epinephrine, on the one hand, and the alkaloid ephedrine, in many respects resembling the action of epinephrine on animals, revealed that, whereas epinephrine was very toxic for living plant protoplasm, ephedrine, or "vegetable epinephrine," was practically non-toxic for it.[15] The drug cantharidin, obtained from the Spanish beetle and used to some extent in medicine, was compared with a most powerful and deadly poison known as ricin, obtained from the shells of the castor-oil seed. It was found that ricin was not at all toxic for growth of *Lupinus albus* in Shive solution, whereas cantharidin, in concentration of 1:50,000, killed it.[16]

Applying phytopharmacological methods to the study of bee virus and extracts of red ants, the author succeeded in demonstrating conclusively that these substances are not irritant by virtue of their content in formic acid but that they contain small quantities of unknown animal toxins.

SNAKE VENOMS

One of the most interesting studies carried on at present by the author is that on snake venoms. The venoms of cobra, rattlesnake, moccasin and other reptiles are being investigated. These poisons, of course, are well known to be extremely deadly for man and other animals. A phytopharmacological study of such poisons, made by dissolving the dried venom in plant-physiological solutions and growing various plants in them, reveals that, if anything, snake venoms are even more poisonous for living plant protoplasm than for animal protoplasm. The author is developing a method of quantitatively expressing the toxicity of these venoms and purposes to use it in connection with the study of various antidotes and therapeutic agents employed for snake-bite.

CONCLUSION

Thus it will be seen that, starting with a purely abstract objective, namely, the comparative study of animal and plant protoplasm in respect to their reaction to various poisons and chemicals, a number of interesting discoveries have been made. These studies are of interest not only to the medical man but also to the biologist, including the botanist and zoologist, on the one hand, and to the chemist, pharmacologist and pharmacist, on the other. The same methods have also been employed by the author for comparative studies of all kinds of chemicals, such as organic mercurials, preparations of digitalis, etc., and have been found very useful. In view of the fact that in all such experimental observations, made not on one or two individuals but generally on ten living plants and sometimes more, an average reading of all the measurements is taken, the results obtained are certainly just as reliable as those gathered from animal test objects, if not more so.

The author is quite aware that the subject of phytopharmacology is only in its infancy, that many additions and modifications in regard to the methods of study and even some of the data adduced will certainly be made, but this is true of all scientific investigation. The results reaped already from his studies on menotoxin, pernicious anemia, leprosy, pemphigus, eclampsia, snake venoms and various animal poisons, however, have fully demonstrated a definite value for this new line of work and, if these discoveries will serve to direct the attention for other investigators to the field, he will be more than grateful for having had the privilege of contributing what little lay in his power to the advancement of experimental science and benefit of humanity. It may be well to conclude with a quotation from an ancient sage:

'Tis not incumbent on thee to complete the whole,
Yet art thou not absolved from doing what thou canst.

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[15] Macht, *Arch. f. exper. Path. u. Pharmacol.*, 143: 329–336, 1929.

[16] Macht, *Proc. Soc. Exper. Biol. and Med.*, 25: 592–593, 1928.

OBITUARY

FREDERICK SLATE

FREDERICK SLATE, professor of physics emeritus, University of California, died at his home in Berkeley on February 26, at the age of seventy-eight years. He was born in London and came to the United States when twelve years of age. He took his bachelor's degree in 1871 at Brooklyn Polytechnic Institute, after which he accepted a position as civil engineer with the Northwestern Pacific Railroad. He entered the University of California as a graduate student in 1873, becoming graduate assistant in chemistry in 1875 and instructor in chemistry in 1876. After two years of study in Germany, he returned to the University of California in 1879 as superintendent of the physics laboratory. On the death of Professor John LeConte in 1891 he became head of the department of physics, which position he held until his retirement in 1918. The University of California conferred on him the degree of LL.D. in 1925.

Professor Slate was active in gaining recognition for scientific courses in the university curriculum and the establishment of a College of Natural Science. He was dean of this college from 1896 to 1909. He took an active part, not only in the early development of the university, but also in the establishment and early growth of the high school system throughout the state. His influence was always on the side of solid foundations and high standards. His publications were mainly in the field of mechanics. In the class room he possessed to an unusual degree the power of clear exposition and the ability to inspire his students with the spirit of work. His teaching was marked by strong individuality and by the demand for exactness in thought and expression. He was a potent inspiration to many. He was a man of great sincerity, truthfulness and loyalty.

ELMER E. HALE

UNIVERSITY OF CALIFORNIA

CHRISTINE LADD-FRANKLIN

THE career of Dr. Christine Ladd-Franklin, who died on March 5, 1930, at the age of eighty-two years, was remarkable in several ways. It was remarkable for brilliancy of achievement. Her theory of color vision, whether or not it shall be the final word on the subject, has certainly done excellent service by holding together the most important facts, and by relating psychology, physiology and photochemistry, along with an evolutionary conception of the development of the color sense. This theory arose out of her study of the theories of Helmholtz and Hering during her work in Germany in 1891–92. She pointed out defects in each of these rival theories and showed how the merits of each could be combined into a single theory. Her work in symbolic logic, perhaps even more brilliant than that in color theory, dates from even further back, from her early days at the Johns Hopkins in 1878–82. Besides these major achievements there were several others of interest, especially her discovery with König in 1895 of the "normal night-blindness of the fovea," and her resuscitation of the "blue arcs" in 1926, and making something of theoretical interest out of this phenomenon.

One of the most remarkable features of her career was her vitality to the last. Her output of publications, which declined from the time when she was about fifty-five, mounted again when she was seventy-five. She maintained to the last her keen interest in all the new developments in her chosen lines. Little of importance escaped her notice, and her judgment and keen power of criticism remained as good as ever. Nor was there any diminution in her zeal for promoting the views which she had espoused.

One should not omit to mention the strong feminist element in her motivation. She was proud of having been a pioneer in university study by women at a time when special private arrangements had to be made in order to allow her the privilege of a university connection, and she was keenly interested in every fresh advance made by women in scientific production. To those who saw her at close range, with her keen logical mind and her cheerful aggressiveness, she certainly appeared a remarkable woman.

R. S. WOODWORTH

COLUMBIA UNIVERSITY

RECENT DEATHS

PROFESSOR STEPHEN A. FORBES, since 1917 chief of the Illinois State Natural History Survey, professor at the University of Illinois from 1884 to 1921, and dean of the college of science from 1888 to 1905, died on March 13 after a week's illness, at the age of eighty-five years. He had been continuously in the state's service for nearly sixty years.

THE death is reported of Dr. Thomas Rakestraw Baker, professor emeritus of natural science at Rollins College, Florida. He was ninety-three years old.

DR. HENRY CHAPMAN MERCER, anthropologist, archeologist, historian and founder of the Mercer Museum at Doylestown, Pennsylvania, connected with the Bucks County Historical Society, died on March 9 at the age of seventy-four years.

Nature reports the following deaths: Dr. G. G. Chisholm, formerly reader in geography in the University of Edinburgh and secretary of the Royal

Scottish Geographical Society from 1910 until 1925, on February 9, aged seventy-nine years; Mr. A. A. Campbell Swinton, F.R.S., known for his pioneer work on X-rays and radio communication, on February 19, aged sixty-six years; Dr. F. Arnall, head of the department of pure and applied chemistry at the Cardiff Technical College, whose interest was mainly in organic chemistry, on February 7, aged thirty-four years, and Professor Felix M. Exner, director of the Zentralanstalt für Meteorologie und Geodynamik and professor of terrestrial physics in the University of Vienna, who was an honorary member of the Royal Meteorological Society, on February 7, aged fifty-three years.

SCIENTIFIC EVENTS

THE FAUNA OF THE BRITISH EMPIRE

THE annual meeting of the Society for the Preservation of the Fauna of the Empire was held on March 4 at the offices of the Zoological Society, London. Lord Onslow, the president, was in the chair.

According to the London *Times*, the report of the executive committee stated that since the last report the acting secretary had made a visit to America solely with the object of enlisting the cooperation of American conservationists in the work of the society. An influential committee had been formed in New York, under the auspices of the Boone and Crockett Club, with Mr. Madison Grant as chairman, and it included Professor Henry Fairfield Osborn, Colonel Kermit Roosevelt, Mr. Childs Frick and Major F. R. Burnham. This committee had charged itself with the collection of a fund to promote efforts with which American conservationists are in sympathy, and it was believed that the society would thereby receive substantial help. The Wild Life Protection Society of America had also, through Dr. Hornaday, generously made a contribution to their funds.

> It was impressed on our secretary in America that it was expected that any help forthcoming from the citizens of the United States of America would be equaled by similar support from our own people. We are confident that this will be the case, but definite efforts are necessary, and we urge our members not to fail us in this respect. The need is urgent. To meet changing conditions we must extend the sphere of our activities. The character of our endeavor during the next ten years will do much to decide the fate of the wild life of the world. This may sound ambitious, but as some 70 per cent. of the larger mammals of the world are in this empire, the responsibility resting on those who claim its citizenship is not to be disregarded. This society, based as it is in the capital city of the empire, and with its twenty-five years' record of achievements behind, can, it is submitted, claim to be the correlating focus of wild life conservation for the dominions, colonies and dependencies which all go to make up the empire of to-day.

Lord Onslow reported that the society wished to carry preservation much farther than it had ever been carried before. That must be done if wild animals were to be preserved in their wild state. As time proceeded, it became more necessary to stabilize reserves by establishing them as absolute sanctuaries. That had been done in America and other countries, and it was by the establishment of national parks in the future that this problem would probably be solved.

He was glad to say that a debate which took place in the House of Lords elicited a satisfactory reply from Lord Passfield, both as to the general policy of the government in regard to game preservation, and to an assurance that the monstrous practice of slaughtering game from motor-cars would be severely dealt with.

A CENTURY OF PROGRESS IN CHEMISTRY

A GROUP of chemists representing leading laboratories in educational institutions and industrial organizations throughout the country has recommended plans for a chemistry exhibit at the Chicago World's Fair in 1933, it is announced by Maurice Holland, director of the National Research Council Science Advisory Committee to the fair.

The group, under the chairmanship of Dr. Arthur D. Little, of Cambridge, Massachusetts, has been collaborating with the Science Advisory Committee in the development of plans for exhibits by all the sciences at the Chicago Fair which is to be held to celebrate the hundred years of progress made since Chicago became a city in 1833.

The chemistry exhibit will include representations of the laboratories, respectively, of an alchemist of the Middle Ages, of some chemist of 1833, and the modern laboratory of 1933. It is suggested that the laboratory of 1833 be the replica of the laboratory of some famous chemist of a century ago. The modern laboratory would be completely equipped for analyses, control work and research.

To illustrate the comprehensive contribution of chemistry to our daily modern life, it is proposed that a typical living room of the 1833 period be exactly reproduced alongside a living room of today by which the differences in living conditions in the two periods would be demonstrated. A descriptive pamphlet telling the story of the change and the part played by chemistry would be distributed. A kitchen of 1833 and one of 1933 are also proposed.

The report recommends that the chemistry exhibits should stress fundamental discoveries and their relation to industry and human welfare; that where desirable discoveries made prior to 1833 should be included; that exhibits should be developed along chronological lines, though not necessarily by distinct periods of time.

It is further suggested that wherever possible the exhibit should include and be developed from something with which the public is familiar, and that the object from which such development should be shown might be either a raw material such as wood or coal, or a final product like an automobile or artificial silk.

The report recommends that one major exhibit be devoted to the study and romance of carbon; that photochemistry should be given emphasis in a special exhibit, stressing its chemical and agricultural aspects as distinct from photography, and that there should be an exhibit illustrating atomic and molecular structure.

It was also suggested in the report that framed portraits of chemists who have made outstanding contributions to the science since 1833 be freely used. A further recommendation provides for a monument emblematic of chemistry, which would embody movement and color and which could be seen 300 feet away.

The chemistry committee in addition to Dr. Little consists of Professor Roger Adams, University of Illinois, Urbana; Professor Wilder D. Bancroft, Ithaca, N. Y.; Professor Marston T. Bogert, Columbia University; Professor R. T. Haslam, Belmont, Massachusetts; Professor Arthur J. Hill, Yale University; Dr. Harrison E. Howe, editor of *Industrial and Engineering Chemistry*, Washington, D. C.; Professor Frederick G. Keyes, Massachusetts Institute of Technology; Professor Arthur B. Lamb, Harvard University; Dr. Irving Langmuir, General Electric Company; Dr. C. E. K. Mees, Eastman Kodak Company; B. C. Mougey, General Motors Corporation; Professor Lyman C. Newell, Boston University; Professor James F. Norris, Massachusetts Institute of Technology; James A. Rafferty, Carbide and Carbon Chemicals Company; Dr. Allen Rogers, Pratt Institute; Charles F. Roth, New York; Professor H. C. Sherman, Columbia University; Dr. C. M. A. Stine, E. I. du Pont de Nemours & Company, and Dr. Willis R. Whitney, General Electric Company.

The Science Advisory Committee is headed by Dr. Frank B. Jewett, president of the Bell Telephone Laboratories, New York City.

THE GEOLOGICAL SOCIETY OF AMERICA

THE forty-first annual meeting of the Geological Society of America and its affiliated societies, the Paleontological Society and the Mineralogical Society of America, was held at the Wardman Park Hotel, Washington, D. C., December 26, 27 and 28, 1929, under the auspices of the Geological Society of Washington.

The meeting was one of the largest in the history of the society, 583 persons being registered. Eighty-five scientific papers were presented before the Geological Society, and the programs of the affiliated societies were also crowded. The address of the retiring president, Dr. Heinrich Ries, on "Some Problems of the Non-metallics," was delivered the evening of December 26, in the auditorium of the National Museum, and was followed by a smoker tendered by the Washington hosts. The annual dinner was held at the Wardman Park Hotel on the 27th.

The officers of the society for the year 1930 are:

President, R. A. F. Penrose, Jr.
Vice-presidents, Nelson H. Darton, Florence Bascom, Herbert E. Merwin, W. H. Twenhofel
Secretary, Charles P. Berkey
Treasurer, Edward B. Mathews
Editor, Joseph Stanley-Brown
Councilors, George R. Mansfield, William E. Wrather, Herdman F. Cleland, Elwood S. Moore, W. C. Mendenhall, W. J. Mead
Representative of the Cordilleran Section, Eliot Blackwelder

IN HONOR OF DR. WELCH

AN international birthday celebration is being planned for the "dean of American medicine," Dr. William Henry Welch, of the Johns Hopkins University, who will be eighty years old on April 8. Simultaneous ceremonies in honor of Dr. Welch will be held on that day in London, Paris, Berlin, Leipzig, Tokio and Pekin, as well as in Baltimore, Cincinnati, New Haven, New York and Washington, D. C., according to the plans announced by the executive committee in charge of the arrangements, of which Dr. Simon Flexner is chairman.

At Washington, the focal point of the celebration, President Hoover will speak on a program in Memorial Continental Hall, beginning at noon, which will be heard over a national hook-up of the National Broadcasting Company. It is expected that the program will also be broadcast by short wave and that it may be heard by those participating in the simultaneous ceremonies in foreign countries.

A unique feature of the celebration has been arranged through the cooperation of Alfred Hutty, the etcher, of Charleston, South Carolina, who was commissioned to make a dry-point portrait of Dr. Welch. The first print from the plate will be given to Dr. Welch at the Washington ceremonies, and there will be simultaneous presentation of other prints from the same etching to more than forty institutions in this country and abroad, with which Dr. Welch has been connected as student, teacher or adviser.

President Livingston Farrand, of Cornell University, has accepted the invitation of the committee to deliver the opening address at the Washington ceremonies, which will be witnessed by an invited audience of eminent scientists and other distinguished men and women.

The executive committee in charge of the celebration consists of Dr. Flexner, chairman; John A. Kingsbury, 49 Wall Street, secretary; Dr. William H. Howell and Dr. William G. MacCallum, of Baltimore; Dr. William T. Councilman and Dr. Harvey Cushing, of Boston; Abraham Flexner, Homer Folks, John D. Rockefeller, Jr., and Wickliffe Rose, of New York; Dr. Eugene L. Opie, of Philadelphia, and Vernon Kellogg and Senator Frederic C. Walcott, of Washington. Professor Albert A. Michelson, of the University of Chicago, has accepted the chairmanship of the general committee, which is now being formed.

"America owes more to Dr. Welch than can ever be told in any tributes," according to the statement issued by the committee. "Half a century ago he began his leadership in modernizing American medicine. Through the reforms which he has instituted in medical study, through his researches, the many hundreds of doctors trained by him, and the vital public health measures which he has inspired, it is literally true that millions have benefited from his contribution."

THE NINTH PLANET

Announcement was made on March 13 by Dr. V. M. Slipher, director of the Lowell Observatory at Flagstaff, Arizona, of the discovery of a celestial body whose rate and path among the stars indicate a new planetary member of the solar family beyond the outermost known planet, Neptune.

Twenty-five years ago Dr. Percival Lowell, who founded Lowell Observatory, began a mathematical investigation for a planet beyond Neptune. The probability of locating such a body, however, was difficult and involved enormous and intricate computations.

In 1914 he announced as the result of his calculations the possibility and distance of the predicted body in a large memoir, a Lowell Observatory publication.

The search of the skies directed by Dr. Lowell's theoretical work was begun by photography in 1905 and has been continued to the present time. The use was made of the best available instruments, the search covering that band of the skies in which the known planet traveled.

Early last year, the Lawrence-Lowell telescope, a highly efficient special instrument for the search, was put in operation. Some weeks ago (January 21) Mr. C. W. Tombaugh detected an object on a plate made with the telescope, which has since been followed carefully.

It has been observed photographically with the large Lowell reflector by C. O. Lampland and it has been observed visually with the larger refractor by the various members of the staff.

All observations indicate the object to be the one which Lowell saw mathematically.

SCIENTIFIC NOTES AND NEWS

The annual stated meeting of the National Academy of Sciences will be held in Washington on April 28, 29 and 30.

The regular spring meeting of the executive committee of the American Association for the Advancement of Science will occur at Washington on Sunday, April 27. Memoranda concerning business to come before the committee at that meeting should be received at the permanent secretary's office in the Smithsonian Institution Building by April 21.

Professor Karl Taylor Compton, now head of the department of physics of Princeton University, has been elected president of the Massachusetts Institute of Technology. Dr. Compton will take office next July, when Dr. Stratton will become chairman of the executive committee and of the corporation, a newly created position in which he will share the responsibilities of administration.

The American Institute of Chemists has awarded its medal "for noteworthy and outstanding service to the science of chemistry and the profession of chemist in America" to Mr. George Eastman, of the Eastman Kodak Company.

The Society of Arts and Sciences has awarded its annual gold medal to Dr. J. McKeen Cattell, psychologist of New York, and to Professor Gilbert N. Lewis, physical chemist of the University of California, for outstanding accomplishment in the field of science. Mr. Walter Russell, president of the society, announces that the formal presentation will be made at a dinner at the Hotel Biltmore on April 17. Last year Professor A. A. Michelson and Professor R. A. Millikan received the medals. Mr. Thomas A. Edison was the recipient in 1928.

The Medical Faculty of the University of Freiburg on March 11 conferred an honorary doctorate on Dr. Herbert M. Evans, professor of anatomy in the University of California, in recognition "of his conspicuous anatomical and biological discoveries, especially in the sphere of vitamin research, both of which are scientific and of world interest."

Dr. Floyd K. Richtmyer, professor of physics at Cornell University, will receive the Louis E. Levy Medal awarded by the committee of science and arts of the Franklin Institute of Philadelphia, at the annual medal-day exercises to be held in the hall of the institute on May 21, for his paper on "Some Secondary Phenomena in X-ray Spectra," which appeared in the *Journal* of the institute for September, 1929.

Dr. Thomas Darlington, of New York City, celebrated on March 12 the fiftieth anniversary of the beginning of his practice. In recognition of his service to the city as head of the Health Department from 1904 to 1910, he received from Dr. Shirley W. Wynne a gold badge bearing the title "Health Commissioner Emeritus."

Baron Koi Furuichi, of Tokyo, has been elected an honorary member of the British Institution of Civil Engineers.

The council of the Royal Society, at its meeting on February 20, as reported in *Nature*, has recommended for election into the society the following fifteen candidates: Herbert Stanley Allen, professor of natural philosophy, University of St. Andrews; Edward Battersby Bailey, professor of geology in the University of Glasgow; Frederick T. Brooks, university lecturer in botany, Cambridge; Paul Adrien Maurice Dirac, university lecturer in mathematics, Cambridge; Harold Ward Dudley, chemist, National Institute for Medical Research, Hampstead; Charles Alfred Edwards, principal and professor of metallurgy, University College, Swansea; Harry Eltringham, entomologist, Hope Collections, University of Oxford; Charles Edward Inglis, professor of mechanism and applied mechanics, University of Cambridge; Harold Spencer Jones, H.M. astronomer at the Cape of Good Hope; Eric Keightley Rideal, lecturer in physical chemistry, University of Cambridge; Robert Robison, assistant chemist, department of biochemistry, Lister Institute; John Stephenson, formerly lecturer in zoology, University of Edinburgh; George Paget Thomson, professor of natural philosophy, University of Aberdeen; Charles Todd, department of experimental pathology, National Institute for Medical Research; William Whiteman Carlton Topley, professor of bacteriology and immunology, London School of Hygiene and Tropical Medicine.

At a meeting of the Geological Society of London, held on February 21, the following officers and new members of council were elected: *President*, Professor E. J. Garwood; *secretaries*, Mr. W. Campbell Smith and Professor W. T. Gordon; *foreign secretary*, Sir Arthur Smith Woodward; *treasurer*, Mr. F. N. Ashcroft; *new members of council*, Professor P. G. H. Boswell, Professor C. G. Cullis, Mr. J. F. N. Green, Sir Albert Ernest Kitson and Dr. Bernard Smith.

The retirement is announced of Dr. Charles A. Wheeler, professor of mathematics at the Connecticut Agricultural College, after thirty-three years of service.

Professor Rodney W. Babcock, head of the department of mathematics at De Pauw University, has been appointed dean of the division of general science at Kansas State Agricultural College, and will enter upon his new work on July 1. Dr. Babcock succeeds Dr. J. T. Willard, who is serving his forty-sixth year as a member of the faculty of the college and who will be assigned exclusively to the duties of vice-president.

Dr. Frederick A. Coller, professor of surgery, has been named director of the department of surgery in the medical school of the University of Michigan. The appointment took effect on the first of March. Dr. Coller, who succeeds Dr. Hugh Cabot, went to the university in 1920 as an assistant professor of surgery. In 1928 he was advanced to the standing of full professor. Dr. Cabot has been appointed senior consultant at the Mayo Clinic, Rochester, Minnesota, effective on June 1.

Dr. Thomas Parran, Jr., assistant surgeon general in the U. S. Public Health Service, was appointed New York state commissioner of health on February 19. His appointment was confirmed by the Senate on March 5.

Cyril Ainsworth, formerly director of the Bureau of Industrial Standards of the Pennsylvania Department of Labor and Industry, has been appointed to direct the national safety code work of the American Standards Association, as announced by William J. Serrill, president of the association. Mr. Ainsworth will direct the work of the association in the establishment of national codes for the guidance of state and municipal governments, industrial organizations and insurance companies. The appointment to the American Standards Association staff has also been announced of John Wilson McNair, formerly of the standards department of the American Institute of Electrical Engineers, and Clarence Edward Darling, formerly of the staff of the American Society of Mechanical Engineers. These appointments are part of a program of extension of national industrial standardization activities. It is expected that the association will have nearly $500,000 available for its work during the next three years.

Dr. H. A. Gleason, curator in the New York Botanical Garden, has been appointed associate editor of the new periodical, *Ecological Monographs,* to be published for the Ecological Society of America by Duke University. Publication will begin in 1931.

Professor Robert F. McCrackan, of the department of chemistry of the Medical College of Virginia, has been appointed chairman of the committee on education by radio of the American Chemical Society. Dr. Otto J. Sieplein, of the University of Miami, and Dr. S. B. Arenson, of the University of Cincinnati, are the other members of the committee.

Dr. and Mrs. N. L. Britton, who have been spending the winter in Porto Rico, where they are continuing their studies of its flora, are expecting to return to New York in April.

After a year of travel in which he covered a distance estimated at 43,000 miles, Professor H. L. Clark, of the Harvard Museum of Comparative Zoology, has returned. He is preparing for classification a large collection of specimens of marine life.

Dr. W. W. Skinner, of the Bureau of Chemistry and Soils of the U. S. Department of Agriculture, accompanied by several chemists of the bureau, is visiting Minneapolis, Madison, Dubuque and Chillicothe, to investigate activities in the utilization of cornstalks, wheat straw, oat hulls, and other farm byproducts. They plan to look further into the possibilities of combating the corn-borer by the commercial utilization of corn-stalks.

Dr. Lee R. Dice, curator of the mammal division of the University of Michigan Museum, and William P. Harris, Jr., of Detroit, associate curator, will make their headquarters at the Desert Laboratory, in Tucson, Arizona, for the next two months, while they study wild life in the desert, particularly mice, rabbits and squirrels.

Professor Herbert R. Moody, director of the department of chemistry of the College of the City of New York, has received a leave of absence for the spring term. He will devote time to a study of chemical industries in Italy and southern France, and will also attend the annual meeting of the Society of Chemical Industry in Birmingham, England, in July. While he is away Professor Reston Stevenson will act as director of the department.

Drs. T. M. Lowry, of Cambridge University, and R. A. Morton, of the University of Liverpool, will be visiting professors on the faculty of chemistry of the Ohio State University during the coming summer quarter. Dr. Lowry will offer courses on optical activity in organic compounds and also on the physical basis (mainly spectroscopic) for chemical theory. Dr. Morton will offer a series of lectures in photochemistry. Professor H. A. Wilson, of the Rice Institute, and Professor W. W. Watson, of Yale University, will also be in residence during the summer quarter. Professor Wilson will lecture on the conduction of electricity through gases and the application of thermodynamics to chemical problems, and Professor Watson on molecular spectra and related topics.

Dr. Kirtley F. Mather, professor of geology at Harvard University, began on March 4 a course of eight illustrated lectures at the Lowell Institute on "The Geologic History of Mankind."

Dr. William F. Foshag, of the Smithsonian Institution and the U. S. National Museum, has been giving a series of twelve lectures at Princeton University at the invitation of the department of geology, on the "Ore Deposits of Mexico." One lecture was given on the "Saline Deposits of the Western United States."

Professor Alexander Silverman, head of the department of chemistry of the University of Pittsburgh, gave an address at the University of Wisconsin on March 19, on "Educational and Research Institutions of Europe." He addressed the Madison section of the American Chemical Society on the evening of March 19, on "Recent Developments in Glass Manufacture." Professor Silverman also addressed the Milwaukee Section of the American Chemical Society on March 21.

The students of physics in the several collegiate institutions in and about Philadelphia held a second joint meeting for the discussion of "Opportunities in Physics" on February 18, in the hall of the Franklin Institute. The speakers were Dr. Horatio B. Williams, of the College of Physicians and Surgeons, New York City, who spoke on "Physics and Medicine"; and Dr. C. C. Kiess, of the Bureau of Standards, who spoke on "Physics and the Bureau of Standards."

Among recent speakers to the Gamma Chapter of Sigma Pi Sigma, honorary physics fraternity, at the Pennsylvania State College have been the following: Dr. Frank C. Whitmore, dean of the school of chemistry and physics at the Pennsylvania State College, who spoke on "Habits of the Atoms"; Mr. William F. Ruder, of the General Electric Company at Schenectady, who discussed "The Effect of Physical Condition on Magnetic Properties," and Dr. R. C. Gibbs, of

Cornell University, who presented an illustrated lecture on "Some Recent Advances in Atomic Spectra." Professor F. K. Richtmyer, of Cornell University, will address the chapter on May 7, on "X-ray Satellites."

DR. W. F. G. SWANN, director of the Bartol Research Foundation of the Franklin Institute, will present one of the principal addresses at the Eugene meeting of the Pacific Division of the American Association which meets from June 18 to 21. The subject of his address will be "Philosophic Concepts in Modern Physics."

THE Wisconsin Academy of Sciences, Arts and Letters, the Wisconsin Archeological Society, and the Midwest Museums Conference will meet jointly at the University of Wisconsin on April 11 and 12.

ON March 8 the Akron Society of Applied Physics and the Central Ohio Physics Club held a joint meeting to which physicists and those interested in physics in the industries and colleges of the state were invited. The program included visits to the laboratories of the B. F. Goodrich Rubber Company and to the Goodyear-Zeppelin Corporation. At a dinner in the University Club the speakers were: Dr. Dayton C. Miller, professor of experimental physics, Case School of Applied Science, "New Evidences of Motion of the Solar System"; Dr. Ellis L. Manning, Research Laboratories, General Electric Company, "A Study of Physics in Industry—Vacuum Tube Research"; Dr. Alpheus W. Smith (represented by Dr. C. W. Jarvis), professor of physics and chairman of the department, the Ohio State University, and Dr. L. H. Thomas, visiting professor at the Ohio State University, from Trinity College, Cambridge University. Action was taken to formulate some sort of organization plans for those interested in physics in the state of Ohio so that this type of program and joint meetings may be a recurrent affair.

HARVARD UNIVERSITY eventually will receive $50,000 for an endowed laboratory for applied practical hydraulics, under the terms of the will of the late Clemens Herschel, the hydraulic engineer. Mr. Herschel bequeathed to the Boston Society of Civil Engineers and the Boston Public Library the right to such of his books as they desire. He also provided that $1,000 each shall go to the Boston Society and to the Harvard Engineering School to be invested to provide prizes for studies in engineering.

THE Carnegie Corporation has recently made a grant of $7,500 to the Y. M. C. A. College Laboratory for Physiologic Research in Physical Education of Chicago. The funds were granted to further researches in the physiology of exercise now in progress.

THE Committee on Scientific Research of the American Medical Association has made a grant of $1,200 to the Medical College of Virginia, Richmond, for the study of lung involvement in human ascariasis. This investigative work will be directed by Dr. F. J. Wampler, professor of preventive medicine, and Dr. Lee E. Sutton, assistant professor of pediatrics. Rather extensive field work as a part of the proposed study will be undertaken during the coming summer.

DR. WILLARD ROUSE JILLSON, state geologist of Kentucky, announces an appropriation by the General Assembly of Kentucky of $100,000 annually during the next biennium beginning as of April 1, 1930, for cooperative topographic mapping in Kentucky. The state appropriation has been matched in the same amount by the topographic branch of the U. S. Geological Survey insuring an expenditure for the surveying of standard topographical sheets in Kentucky during the next two years of $400,000. About 70 per cent. of the 40,598 square miles in Kentucky is now topographically surveyed, and it is hoped to complete the state within about three years.

AN Institute for Fisheries Research has been established at the University of Michigan. It will be responsible for conducting the investigations in economic ichthyology called for by the Michigan Department of Conservation, which is subsidizing the institute. In investigations on the commercial fishes and fisheries of the Great Lakes, the Department of Conservation will continue to cooperate with the Great Lakes Laboratory of the United States Bureau of Fisheries, which like the new institute, has headquarters in the Museum of Zoology of the University of Michigan. The institute is planning to add a number of men to its staff, and expects to offer a number of fellowships in fisheries research.

THE Home for Incurables, the Bronx, New York City, will receive a bequest of nearly $900,000, according to the terms of the will of George W. Ellis, a real estate lawyer, who died on February 8. The State of Vermont will receive $100,000, providing that the University of Vermont, Middlebury College, of which Mr. Ellis was a graduate, and Norwich University are merged into one institution under state control. "This institution should eliminate all needless duplications and waste," wrote Mr. Ellis in his will, "and, regardless of creed or birth or wealth or social position, shall aim to educate and train morally, mentally and physically those expecting to retain a residence or occupation or property interest in the State of Vermont." If this provision is not carried out, the $100,000 bequest is to revert to Columbia University "for a like educational purpose."

Tennessee is the first state selected by the Commonwealth Fund for carrying out its new rural health project in cooperation with health departments in two or three states. Gibson county in the western part of the state has already been chosen as one of the two counties in which field work will be developed. In accordance with the general plan, Vanderbilt University is to receive a grant for developing the teaching of preventive medicine and providing opportunities for graduate study by rural physicians, and the University of Tennessee will be given funds to organize training courses for teachers in health education.

The Kentucky Legislature has passed over Governor Sampson's veto the bill providing for acceptance of the offer made by Former Senator T. Coleman du Pont, of Delaware, to provide $230,000 for the acquisition for state park purposes of an area of approximately 2,200 acres at Cumberland Falls.

Museum News reports that an official party representing the Department of Interior and interested organizations made an inspection, lasting from February 11 to 15, of the site of the proposed Tropic Everglades National Park in the Cape Sable district of Florida. This party included Dr. Hermon C. Bumpus, of the American Association of Museums; Dr. T. Gilbert Pearson, of the Audubon Society of America, and E. K. Burlew, personal representative of the Secretary of the Interior, as well as Director Horace M. Albright, and other officials of the National Park Service. The inspection was made under congressional authority. The itinerary included a cruise over the territory in a blimp, a trip by water down the Florida Keys and through Florida Bay and the upper reaches of White Water Bay, and an automobile tour out the Tamiami trial from Miami. The findings of the investigators have not yet been made public.

The National Tuberculosis Association announces a limited number of fellowships in social research as related to tuberculosis, open to graduate students who have had special training in statistics, social science or public health. Preference will be given to candidates who are interested in pursuing research in public health after the completion of this fellowship. Researches on topics selected by the National Tuberculosis Association will be conducted in collaboration with colleges and universities, and each study will be under qualified academic leadership. Academic credit may be allowed for this research according to arrangements with the individual universities under whose supervision they are undertaken. Each fellow will be required to submit a written report at the completion of his fellowship grant, and the text of that report shall remain the property of the National Tuberculosis Association. Candidates will be considered not alone on academic standing, but on experience and general fitness for research work. The fellowship grants will date from the beginning of the academic year in the fall of 1930. They are for a twelve-month period, and the fellowship grant amounts to $1,500 for that period with a month's leave for vacation. Interested candidates should write to Jessamine S. Whitney, Statistician, National Tuberculosis Association, 370 Seventh Avenue, New York City, for further information.

DISCUSSION

THE ECLIPSE OF APRIL 28

The brief duration and the narrow path of totality of this eclipse, visible in California, make the question of the accuracy of the predictions of some interest to observers. Perhaps a brief statement of the problem, free from technical terms, may be of value.

The errors of the prediction arise mainly from two sources, namely, those due to lack of full knowledge of the motions of the Earth, Moon and Sun, and those due to the topography of the Moon's limb. Owing to a variety of causes, the former have been much diminished during the past six years. There is still some uncertainty due to the changing rate of rotation of the Earth, but this affects the position of the path less than it does the time at which totality occurs. In the coming eclipse the position is of importance because a small error may cause the observer to miss totality altogether. In a discussion just published in No. 934 of the *Astronomical Journal*, Dr. D. Brouwer has used all the latest available information, and we estimate that the uncertainty, due to these causes, of the position of the path given by him in a direction perpendicular to the path is less than a quarter of a mile.

The uncertainty due to the topography of the Moon's limb is larger than this. We have plenty of evidence of valleys on the limb a mile or more deep, and of mountains even higher than this amount, but our knowledge of their exact position at the time of the eclipse is not sufficient to enable us to use it for prediction. A valley a mile deep at either of the positions where the grazing edges of the Sun and Moon give the limits of totality on the Earth may alter the edge of the path on the Earth by a like amount. In the present case, where the predicted width of the path is considerably less than a mile, it may result in a complete absence of totality anywhere. Professional observers are aware of these facts, and have made up their programs accordingly. Certain classes of observation can be usefully undertaken with these conditions in view.

Ernest W. Brown

Yale University

WAS MAGENDIE THE FIRST STUDENT OF VITAMINS?

Few investigators have had the rare fortune to make two classical discoveries in one series of investigations. To Magendie must be ascribed such a feat. In a report entitled the "Nutritive Properties of Substances which Contain Nitrogen," which was published in 1816,[1] Magendie showed that dogs can not live upon fats, sugar and water but must have some form of nitrogen in their food. The importance of this discovery was such that it seems to have eclipsed the remainder of the report.

Magendie fed his dogs upon a diet of sugar and water. They lost weight steadily. The remainder of the experiment can not be expressed more concisely than in the author's own words:

> In the third week his [the dog's] thinness increased, his strength diminished, the animal lost his liveliness, his appetite was not so keen. At this same period a small ulceration was developing in the center of the transparent cornea, first on one eye and then on the other, it increased rapidly and at the end of a few days was more than a "ligne" [two millimeters] in diameter. Its depth increased in the same proportion; soon the cornea was entirely pierced and the fluid of the eye was flowing out. This singular phenomenon was accompanied by an abundant secretion of the glands of the eyelids.

This animal died. Autopsy showed little other than the effects of inanition. Magendie was a careful investigator. The experiment was repeated two times with identical results. Has any modern investigator presented a clearer picture of xerophthalmia?

In order to test the nutritive value of fats, a diet of olive oil and water was fed another dog. This animal died but showed no xerophthalmia. Another dog fed butter fat and water developed xerophthalmia in one eye! These results are of special interest in the light of modern work, since they are the reverse of modern experiments.

Magendie seems to have realized that he was dealing with a dietary deficiency, since he found normal chyle in his animals at the time of autopsy. His own statement is that "it is thus evident that if these diverse substances [fat, sugar, gum and water] do not nourish, we should not attribute this to the fact that they are not digested."

Magendie noted the marked changes in the urine, feces and bile that resulted from a diet lacking protein and suggested: "Can we not reasonably presume, after the experiments which I have reported, that by diminishing the nitrogenous substances in food we diminish the proportions of materials in the urine which give rise to gall-stones?"

Not only did Magendie record the production of xerophthalmia in animals but he recognized the analogous conditions in man as a result of a restricted diet. He reported this as follows:

> A very interesting experiment has recently been done by an English doctor named Stark. This doctor wishing to estimate the nutritive properties of sugar lived on it exclusively for about one month, but he was then obliged to give up this régime. He had become very feeble and bloated. In his sight appeared livid red spots which seemed to announce the approach of an ulcer. He died a short time after his experiment and the people who knew him thought that he might have been the victim of it.

Magendie closes this classical report with, "I wish that physicians would be inclined to make trials of this kind. Physiology, animal chemistry and medicine can gain from it."

Must Magendie be termed the father of the vitamin hypothesis, as well as the discoverer of the need for protein in the diet?

C. M. McCay

Animal Nutrition Laboratory,
Cornell University

DROSOPHILA ONCE MORE

In a recent number of Science[1] Dr. Bessie B. League publishes a summary of her observations on the reduction divisions in *Drosophila melanogaster*. It is gratifying to find some one on this side of the Atlantic who will admit that the phenomena accompanying the reduction division in this extremely variable species are abnormal. I have found genetical and cytological colleagues most determinedly of the opinion (not, however, expressed by publication) that the meiotic divisions of this species are quite normal, and so much so that it had not been worth while to figure them. I have had to point out that one so presumably well acquainted with the genetics and cytology of Drosophila as Professor Morgan admitted so late as 1925 that little or nothing was known of the reduction division in this species. I find great diversity of explanations offered by genetical colleagues of the peculiar situation which exists in regard to our knowledge of the reduction division in this species. I have already pointed out that although sex chromosomes in practically every other case among animals and plants are recognized and described in the reduction division, in *D. melanogaster*, in striking contrast, in spite of the enormous amount of work on the species, no adequate account of the reduction division has ever been published until very recently. This in itself is a surprising anomaly which the Drosophilists owe it to themselves to explain.

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[1] *Annales de Chimie et de Physique*, 1 series, 3: 66, 1816.

[1] Science, 71: 99, January 24, 1930.

Dr. League's observations, interestingly enough, correspond closely with those recently published by Zuitin in the Genetical Bureau of the University of Leningrad.[2] The article is entitled in the English summary which accompanies the Russian text, "On the Peculiarities of Spermatogenesis in *Drosophila melanogaster*." This author's account confirms the observations made by the present author, and he reaches the conclusion that *D. melanogaster* is an interspecific hybrid, on the basis of its abnormal cytology. The article is accompanied by a number of figures, which in some cases closely parallel those published by the writer in 1925.

It is thus clear, on the evidence of three independent observers, that there are abnormalities connected with the reduction division of *D. melanogaster*. It seems obvious that it is impossible to explain these abnormalities by reference to *D. melanogaster* alone. Obviously the general situation must figure largely in connection with the whole discussion. We know that in the case of many hybrids there are lagging chromosomes and chromosomes extruding into the protoplasm, such as are not found in the parent species of these hybrids. This is particularly true of hybrid plants, because our information in regard to these is very much fuller than it is on the zoological side. The cytological peculiarities of reduction division of *D. melanogaster* exactly parallel those found in hybrid plants. Dr. League explains the lagging chromosomes as resulting from the fragmentation of plasmosomes. This explanation is very difficult to accept in view of the fact that quite normal plasmosomes have been described both by Stevens and the present author.

A very strong point in connection with this discussion is the fact that synapsis has been observed in the reduction division, and has been figured in two of the articles published by the present writer. The synaptic mates which, as is well known, appear in diakinesis and the metaphase of the reduction division in plants and animals are distinctly present and distributed along the spindle in a way which is common for a number of known hybrids, and for some extremely variable species which are probably of hybrid origin. While it may be possible to explain small clumps of apparent chromosomes occurring on the spindle and in the protoplasm in *D. melanogaster* as of plasmosomal origin or even as mitichondria, the synaptic pairs of chromosomes can not possibly be interpreted in this way. Further, fragmentation of chromosomes, as well as ejection into the protoplasm, is not uncommon in hybrids. It is thus extremely probable, in the light of all the facts, that the material lagging on the spindle and ejected into the protoplasm in the reduction division of *D. melanogaster* is of the nature of chromatin, especially as no corresponding structures are present in the somatic divisions. This view gains a high degree of credibility from the fact that we have these fragments of chromatin only in the heterotypic and homotypic divisions, precisely as is the case in known hybrids. This appears to show clearly that they have a peculiar and characteristic relation to meiosis. They parallel, in fact, in their behavior, exactly the conditions found in many known hybrids in plants and animals. It is accordingly assumed that the reduction phenomena in *D. melanogaster*, viewed from the general standpoint of our present knowledge of the cytology of hybrids, indicate clearly the hybrid origin of that species.

If the whole situation is summarized for *D. melanogaster*, it is very apparent that it manifests in a striking degree the peculiarities of an interspecific hybrid. In the first place, the species is heteroploid, showing not only eight and twelve somatic chromosomes but also dysploid modifications of these. This is a recognized heterozygous feature. Further, not only within this much-investigated species does heteroploidy occur, but in others of its large and variable genus, in which the specific enumeration has already reached two hundred. This is a feature of resemblance to other large and mutable genera which manifest all the characteristic features of hybrid contamination. Further, *D. melanogaster* is characterized by a high degree of sterility, another known heterozygous feature. Finally, we have at last the reasonably complete account of the reduction division from three independent, remote sources, which all set in relief the abnormalities in meiosis, which are precisely those found in hybrids. It is true that Dr. League claims that the real chromosomes of the species under discussion behave as in normal species. That is frequently the case in hybrids. Moreover, they do not behave normally in the crucial stage of the metaphase, in which the synaptic mates are present. Further, all recent investigators admit the presence of lagging material on the spindle and in the cytoplasm, precisely as is the case in known hybrids. Zuitin and the present writer claim that this material is chromatin, or at least contains chromatin, while Dr. League maintains the difficult position that it is of plasmosomic origin. If it were, we would expect to find similar material present in the somatic divisions, which is not the case. This consideration apparently eliminates the interpretations of both Dr. League and Belar of the lagging and ejected material. Moreover, true plasmosomes are present in the spermatocytes and spermatids of *D. melanogaster*. Finally, the conduct of the lagging and ejected material is precisely that found in many known hybrids.

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[2] *Bulletin* of the Bureau of Genetics, Vol. 7, Leningrad, 1929.

It is thus clear that *D. melanogaster* has so many of the characteristics of a hybrid that only its duplication by the experimental crossing of recognized species could supply additional evidence in this direction. It is further indicated that it is time that we had surcease of speculations on the part of geneticists as such on the general problems of evolution and the origin of species. No amount of Mendelian moiling with the stabilized variants of a mutable species is likely to throw any permanently valuable light on the question of the origin of species. The real problem is clearly that of the origin of mutability in modern types of plants and animals, a matter upon which the conscientious and even contentious elaboration of the laws of Mendel throws no light whatever. Cytology and the experimental crossing of species are obviously destined to lead the way to new and fundamental advances in our knowledge of the origin of contemporary species of plants and animals.

IN a recent number of this journal[3] Professor Huettner passes some criticisms on my work on *Drosophila melanogaster*. These are largely expressions of the dis-esteem of himself and his group of Drosophilists for my work on this species and includes some quite erroneous statements in regard to my qualifications. As these matters are of little scientific interest, it will be well to refer to the only significant feature of his paper, namely, the question he raises as to the lagging of the chromosomes in the species under discussion. He commends strongly in this connection the use of Feulgen's reagent for the identification of the real chromosomes. Putting aside the question as to the extreme abnormality of the reduction division in *D. melanogaster* as in itself a suspicious circumstance, my critic is referred both to the article cited above and more particularly to a recent paper by Woskressensky and Scheremetjewa on spermatogenesis in *D. melanogaster* published in the *Zeitschrift für Zellforschung und mikroskopische Anatomie*. The latter authors use the method of Feulgen, and their figures show a very large amount of lagging in the chromosomes of the species as diagnosed by this method. Further, their account agrees with that of the present writer in respect to the multiplication in number of the chromosomes beyond that to be expected from the somatic conditions. The tide in regard to the interpretation of *D. melanogaster* has apparently definitely turned, as the newer literature has abandoned the contemptuous attitude which has been in general adopted by Drosophilists on this side of the Atlantic.

E. C. JEFFREY

HARVARD UNIVERSITY

SCIENTIFIC NAMES IN ZOOLOGY

A VERY considerable number of interested zoologists believe that real progress is being made in zoological nomenclature. A sane use of the highly valuable principle of priority is being made, despite the unwillingness of an ultra-conservative group to adopt any change from the nomenclature it is accustomed to and therefore regards as the proper one, and despite the objections of another group now also being forced into a conservative position by the progress which is being made. This second group would insist on the resurrection of any available name which has priority, no matter how much inconvenience the change would introduce. The International Commission on Zoological Nomenclature is in general steering a median course, by using its plenary power very wisely in eliminating from the rule of priority those occasional names which would clearly create a really wide-spread confusion and instability, and in consistently refusing to pass favorably on cases in which the replacement of the established name affects only a few systematists or in which the desirability of the replacement is clearly debatable or in which the proposed change involves taxonomic judgment rather than the application of the rules.

Those of us who view the progress in nomenclature more or less optimistically are perturbed by the expression of views which can only serve to obstruct the advance which is being made. We feel that such an article as that of Professor Needham[1] is particularly reactionary. Since this account is well and boldly written and since a considerable weight of authority is carried by the author, the remarks of Professor Needham are meeting in some quarters with a reception which we believe to be unjustly favorable. We feel constrained to attempt a reply.

Needham's "smouldering impulse first burst into flame" over some modern names to which he objects. Of course not all names are of equal euphony or brevity, and it is possible to search out some which are flagrant examples of poor style. Zoologists alone are not responsible for such unpleasant productions. They blight the terminology of other sciences. Indeed, some words in common use are not simple.

The discussion of these long names of the day by Dr. Needham gives a very unfair picture. Many modern names are a joy to the zoologist and the classicist alike; many old names are badly constructed and long. But that two names of record length "are far worse than anything pre-Linnaean" is not the truth. The first name quoted belongs to a set which the International Commission has recently specifically outlawed, in Opinion 105 (published June 8, 1929, with preliminary notices in 1927)—a fact of which our critic was either ignorant or which he ignored. The second name is further elongated by Needham himself by the insertion into its middle of three more letters, thus carrying it so far from bad to worse that the senior author of the name may perhaps be happy that Needham added a letter to his name also. Some of the names which Needham holds up to ridicule apparently sounded and looked bad to him because of their Slavic form, and to this degree his course is surely unjustified.

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[3] SCIENCE, 71: 241, February 28, 1930.

[1] SCIENCE, 71: 26–28, 1930.

The impression is given by Needham that such awkward, bestretched names are very general: "If any one thinks that such monstrosities in names are isolated cases let him read the four pages of generic names derived from personal names in Palmer's 'Index Generum Mammalium.'" But the very names Needham cites are notorious exceptions; in fact, they are the very ones I myself have quoted in objecting to such names. We therefore can not regard such abuses as being at all common. The International Commission has refused to validate a group of crustacean generic names of which the one quoted by Needham is an example. On account of the circumstances of the case, I think the commission was justified in this arbitrary action, the first of its kind ever taken. But to outlaw inelegant names except in most unusual conditions would be dangerous and unjust, and would discredit the commission out of the authority it now commands among systematists.

It is amusing to note that men like Raffinesque a century ago replaced names which appealed to them as too long (or too short), but for such an action to be advocated to-day is an unpleasant anachronism.

Needham's critical attack appeals to us as essentially destructive. He does, however, make some suggestions, of very unequal promise. The general proposal for the erection of a new body to pass on taxonomic as well as nomenclatorial evidence and so build up a "standard name list" strikes us as very unwise and dangerous. Such a body would certainly command at most very limited and ephemeral authority. Active systematic zoologists as a whole would certainly not tolerate an effort to subjugate individual scientific judgment to an ordained system of names.

We trust that Dr. Needham will not deny that scientific judgment does enter into systematic work. We trust that he knows that even supposedly very well-known species are often found to be complexes of two or more species, or to be wrongly classified. We trust that he appreciates that accurate species identification is essential to sound comparative work in almost any field of zoology. We trust that he realizes that the fine distinction of forms is especially conducive to new interpretations in such fields as ecology, zoogeography and economic zoology. To have a fixed system of names for others than systematists would make the advances of systematists unavailable to other zoologists and would inhibit broad cooperative progress in the whole field. The suggestion for a name-fixing body seems to us little better than the discarded scheme for numbering species.

The proposal to submit our problems of nomenclature to psychologists will certainly hold little interest. The proposal for botanists and zoologists to cooperate may be worth considering, when the botanists among themselves agree to one code of rules. The proposal for "members-at-large in the name-choosing body, to secure a measure of uniformity" expresses a poor appreciation of the function which an International Commission on Zoological Nomenclature should (and has) assumed. The proposal to have members of the name-choosing body serving only for the groups in which they are taxonomic specialists, to bring to bear a working knowledge of the group and of its literature and tradition, would involve a commission of unwieldy size and overlooks the fact that the present commission ordinarily does submit cases to specialists in the group involved. The specific "tradition" of one group ought not to bear on questions of nomenclatorial rules, which are rightly the primary concern of the International Commission. The proposal for "Some better method of obtaining the opinion of zoologists than the *viva voce* vote of the crowded sessions of an international congress" is accompanied by no mention of the fact that the secretary of the International Commission makes strong efforts to bring proposed cases before the general zoological public for its opinions.

That the existing system of zoological nomenclature is in many ways crude and in need of revision is undeniable. That scientific names are so confused, absurd or appallingly long as to dull the interest of the pupils of conscientious teachers is a very minor pedagogical objection, if true. That "good judgment, expert knowledge, human sympathy, hard labor and long patience" will be required "to find a way out" is granted, but we need not completely ignore the fact that some degree of these noble qualities has already been mixed with the almost fiendishly egotistical passion of systematists (as pictured to us), in building up the nomenclature and the rules which hold to-day.

Needham is of course not alone in longing for a simple system of nomenclature. Most of us do. How to obtain such an end is a common question. The solution is obviously, as Needham now admits, not to be found in any such device as numbering species. The use of quadrinomials I also object to; it is confined to few authors and to few groups of animals, and is not recognized by the International Rules, to which Needham makes too little reference. The use of trinomials to designate incompletely differentiated forms most systematists believe to be sound and unavoidable, and when logically applied leaves the binomial specific name available for the use of those who do not need or those who do not care or those who are unable to split the subspecies of the species in question.

Thus the evil, or virtue, of subspecies "splitting" need not worry those who long for a simple nomenclature (even if the simplicity be artificial). The splitting of species, when sound, unavoidably alters the scientific name and can be ignored only through ignorance or arrogance. The splitting of genera into subgenera need not worry the worshipers of brevity, for there is no need for quoting the subgenus in the scientific name. But the splitting of genera into smaller genera does alter the name. So does the transfer of species from one genus to another. The Rules of Nomenclature have no primary application to such taxonomic changes. These changes are at the base of an ever-increasing proportion of the unfortunate shifting of names. Fewer and fewer alterations are due to the uncovering of overlooked available names or to alteration of the species interpretations.

It is becoming increasingly clear that these name changes, due to genus splitting or shifting, are the chief concern of those who long for a stable nomenclature. It is unfortunate that the changes in genus concept should alter the scientific name of an animal. The fault lies in the binomial system of nomenclature. This system confounds classification, which ought to be flexible, with nomenclature which should be fixed. A uninomial system of animal names would divorce classification from nomenclature and would presumably emphasize the fact that the species is the most natural and objective of all systematic groups. It would certainly shorten animal names. The uninomial system has been found workable in mineralogy, chemistry and astronomy, and would have many advantages in zoology.

I do not propose the present adoption of any uninomial system of zoological nomenclature. I do emphasize, however, the facts that the tendency to split has continued, despite occasional set-backs by lumpers, from the time of Linnaeus until the present; that in some groups the splitting of genera has gone so far as to produce a high percentage of monotypic genera; that for such groups there is a tendency, in conversation or in general works or in the frequent repetition of the name in technical papers, to allow the generic name to stand for the whole scientific name. We are to this degree now heading toward a uninomial nomenclature of animals. That this system will be gradually and eventually adopted I venture to predict. If the uninomial system is not accepted, or until it is, I see no hope for ever arriving at a really stable nomenclature. In the meantime we can devise ways of surviving without this stability.

Carl L. Hubbs

University of Michigan

SEA-LEVEL CHANGE NEAR NEW YORK

In *Bulletin* of the National Research Council, Number 70, just issued, there is an erroneous statement. On page 35, paragraph D, it is stated that "Tidal observations at Fort Hamilton extending over a period of 35 years indicate no appreciable change in sea-level at that point during the period of observations."

As a matter of fact, the probable change in sea-level at Fort Hamilton between 1893 and 1927 is at the average rate of a rise of one foot in 214 years (by the least square method 0.0047 feet a year ± 0.06). Though the probable error of this result is great, it is more likely to be at the rate of 0.6 feet per century (.006 feet per year) as suggested by J. R. Freeman than to be with "no appreciable change."

Curiously, taking the last twenty-five years, from 1903 to 1927 inclusive, the rate would be .0055 feet a year.

The whole question deserves further consideration which we hope it will receive. For instance, M. R. Campbell's suggestion that meanders in streams flowing essentially at and below tide level are indicative of drowning, Bull. G. S. A. (1927) pp. 537–555, has a bearing.

Alfred C. Lane,
William Fitch Cheney, Jr.

ASTRONOMY IN SOUTH AFRICA

The paragraph quoted from *Science Service* in the issue of December 20, 1929, headed "Astronomy in South Africa," contains several inaccurate statements.

The large refractor of the Radcliffe Observatory has an aperture of twenty-four inches, not eighteen inches. The University of South Africa does not possess an observatory, and there is no observatory in Cape Town other than the Royal Observatory. The twenty-four-inch photographic refractor of this observatory has an eighteen-inch visual refractor on the same mounting.

Neither the University of Michigan nor the Yale University has branches in the grounds of the Union

Observatory, Johannesburg. The University of Michigan southern station is on Naval Hill, Bloemfontein; the Yale University southern station is in the grounds of the University of the Witwatersrand, Johannesburg. The southern branch of the Harvard Observatory is at Mazelspoort, about fourteen miles outside Bloemfontein.

H. SPENCER JONES
H. M. Astronomer

SCIENTIFIC APPARATUS AND LABORATORY METHODS

SHAKING MACHINE FOR ANALYTICAL WORK

THE world's industrial progress has been measured by a number of different inventions, especially applied mechanical devices. When time became very precious, as it is in our days, human ingenuity had to stretch its limits seeking some machinery to save labor and energy.

A chemist in his laboratory, for example, knows how to appreciate all his apparatus which make him able to carry on his research or routine work quite conveniently. The shaking process, which is sometimes an important factor in analyses, is a very tedious and time-consuming operation. Yet, using a properly constructed shaking machine, the process becomes easy and simple. The shaking machine will do good and rapid work in many instances.

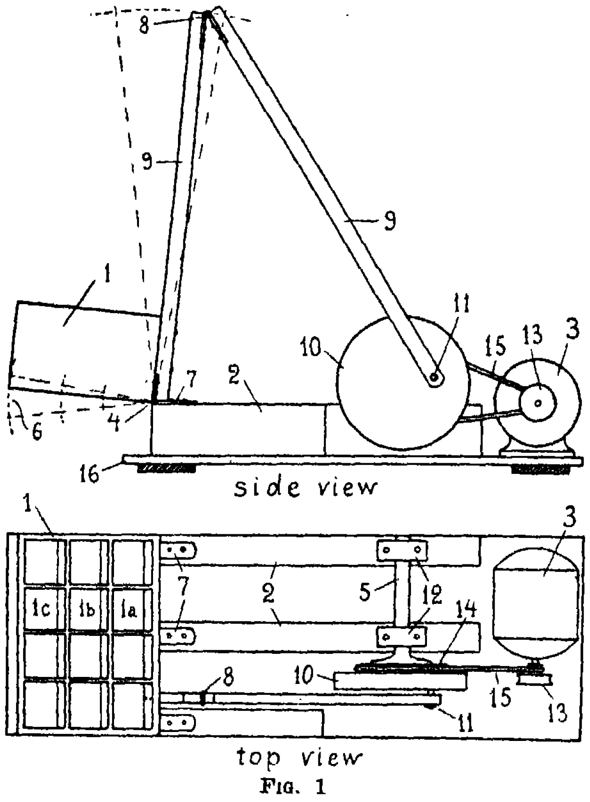

FIG. 1

The accompanying diagram represents one of the many useful shaking machines which have been designed and used in my laboratory of experimental embryology. This machine consists of a box with compartments (1) hinged to a base (2) and brought into a swinging motion by an electric motor (3) through a mechanical "system of four-links chain," where (4) and (5) are the axes of oscillation and rotation, and (6) is the maximum amplitude of swinging. Other parts of the machine are indicated: the hinges (7) and (8), shear legs (9), fly wheel (10) with crank and pin (11), bearings (12), motor pulley (13), driving pulley (14), belt (15) and base plate (16).

The shaking can be done in the box (1) with several samples under various amplitudes of swinging. The first row of compartments (1a) provides mild, the second (1b) moderate and the third (1c) intense shaking. If it is necessary, the amplitude of swinging in the machine can be easily adjusted by displacing the crank pin (11); and the speed of rotation can be regulated by the speed of the motor (3), using either a rheostat or several sizes of driven motor pulleys (13).

The machine described above, owing to its double action, or "swinging motion," might be particularly desirable in a thorough but gentle shaking or in any other special type of analytical work.

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AN APPLICATION OF STREAK AND HARDNESS USED IN CLAY GRADING

THE streak of a mineral is commonly used by mineralogists and geologists in its determination when the hardness of the mineral is less than that of the streak plate, but it is seldom that the mineral specimen itself serves as the streak plate for another substance and is thereby identified. This latter method, however, is used by workmen mining diaspore clay in Missouri to estimate the quality of the diaspore in the clay pits.

They have observed that when a lump of diaspore clay is broken by either a pick or "gad" (a steel wedge) a dark mark, the streak of the abraded steel tool, is left upon first-grade clay, whereas the inferior clay is only crushed or compressed where it is tooled. The workmen speak of the clay as "blacking" or "marking" well when the streak left upon the clay boulder by the iron tool is distinct.

Furthermore, it is known that the degree of "blacking," *i.e.*, the intensity and depth of color of the streak, varies directly with the alumina content of the clay. Since the value of high alumina clay is determined by its refractory quality and since this is dependent largely upon the alumina content, the depth of color of the dark streak is a valuable aid in estimating the quality of the clay. In practice a grader observes the "mark" made by the tool or his grading hammer, and quickly noting the fracture, texture and oolites present in the clay, sorts it into first grade, second grade or burley with a speed and accuracy that are surprising. An estimation of the alumina content to within 5 per cent. is regularly made, and under favorable conditions car-load quantities and even larger of one grade may be supplied with still less variation.

Although, upon a cursory examination, the test as outlined above might seem crude and undependable, its practicability is more evident after a review of some of the factors involved. Diaspore and burley clay are made up of the mineral diaspore, which contains 85 per cent. Al_2O_3, and a bonding matrix that is kaolin-like, its alumina content being in the neighborhood of 40 per cent. The hardness of diaspore is 6.5–7 (Dana), whereas that of kaolin is 2–2.5. It is evident that diaspore will scratch or cut steel, and that the kaolin-like matrix will not. Hence, the higher the diaspore content of the sample the more marked its abrasive action will be, the darker the streak of steel and the higher the alumina content. The clay functions both as a hardness element and as a streak plate. Quantitatively, clay containing 60 per cent. alumina and above will usually retain a mark, whereas that below 60 per cent. only packs or crushes to a slightly darker color and does not cut steel. An intense black to blue-black color is left upon clay running over 70 per cent. in alumina.

It might also be noted here that the clays higher in silica break with a more typical conchoidal fracture, those lower in silica with a more hackly break, similating, in this respect, the rhyolite-basalt fracture contrast. While the writer does not wish to indicate that the cause of the conchoidal fracture lies entirely in the high silica content he does wish to show that a relationship is suggested, and he points out the analogy to the igneous rocks because of its lithologic interest. A fuller discussion of the various means used in grading the high alumina clays of Missouri is published in *Brick and Clay Record*, October 8, 1929.

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SPECIAL ARTICLES

AN AQUEOUS EXTRACT OF THE SUPRARENAL CORTEX WHICH MAINTAINS THE LIFE OF BILATERALLY ADRENALECTOMIZED CATS

IT is a well-established fact that in cats and dogs bilateral adrenal extirpation results in death within a short time, generally within eight to ten days. The animals exhibit a train of symptoms which has come to be recognized as typical of adrenal insufficiency. Experiments have shown, moreover, that death is due to removal of the cortical portion of the suprarenal complex and not to interference with, or loss of, the medulla or adrenalin-containing portion.

Administration of adrenalin to bilaterally operated animals has been repeatedly tried but without success, since animals so treated derive no benefit from the injections and die with characteristic symptoms of adrenal insufficiency. We have made numerous attempts to prolong the life-span of adrenalectomized cats by injections of adrenalin, employing various dosages, but in no case have we noted any improvement in the condition of the animals or been able to prevent the onset of symptoms.

During the past two years the writers have concentrated their efforts upon the cortex of the suprarenal and have prepared and tested a large number of different cortical extracts and have used over three hundred and fifty cats in the experiments. Varying degrees of activity were obtained from several of the preparations, and one lipid fraction revealed a considerable degree of potency. A brief report of the early work was published in the abstracts of the American Society of Zoologists.[1] Since the abstract was written, however, the lipid fraction was further fractionated and an aqueous preparation obtained which shows greater potency than the original lipid extract. This fraction is prepared in the following manner.

The suprarenal glands (beef) packed in ice are received from the slaughterhouse within twenty-four hours after the death of the animals, and the cortex dissected as free as possible from extraneous fat and medullary tissue. The ground cortical tissue is extracted at room temperature successively with 95 per cent. ethyl alcohol and 80 per cent. ethyl alcohol for varying periods of time, usually about three or four days, although we have obtained active extracts from material stored in 95 per cent. ethyl alcohol at room temperature for three weeks. The extractives are concentrated separately in partial *vacuo* at a low temperature and the residues thoroughly extracted with benzene. The benzene is removed in partial *vacuo* at a low temperature and the lipoidal residue extracted with acetone. The acetone-soluble material, after removal of the acetone in a similar manner, is distributed between 70 per cent. ethyl alcohol and low-boiling petroleum ether. The alcoholic phase is washed repeatedly, the petroleum ether washings combined and the petroleum ether removed by distillation. The residue is again subjected to the distribution procedure. The petroleum ether washings are washed with 70 per cent. alcohol. The alcohol is removed as before, and to the aqueous concentrate sufficient distilled water is added to obtain the desired volume. In the present study we have arbitrarily made the dilution so that 1 cc represents 30 gm of freshly dissected cortical tissue. The extract is clarified and sterilized for subcutaneous injection by filtration through a Seitz filter. The solid content of this extract varies between five and ten milligrams per cubic centimeter. The extract is not entirely adrenalin free.

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[1] *Anatomical Record,* 44: 225, 1929.

Present knowledge of the functional significance of the suprarenal cortex is so vague and uncertain that the only reliable criterion for testing the activity of a cortical extract is its effect upon the life-span of adrenalectomized animals. The criterion is severe and requires much time and effort, but at any rate it is an excellent index of potency.

All cats, both controls and extract-treated, were given uniform treatment. They were treated with a vermifuge upon first admittance to the laboratory—a necessary precaution since many animals in the vicinity of Princeton are heavily infested with hookworm—kept in thermostatically heat-regulated rooms, fed identical diets and operated by the same individual. At least seven days intervened between removal of right and left adrenals.

The average life-span of twenty-five bilaterally adrenalectomized control cats (untreated) was seven days; the maximum survival period of any animal in the control series was fourteen days; the minimum survival was four and one half days. Twenty-four hours following the second operation the first injection was given. Each animal received subcutaneously 0.5 cc to 1.0 cc of extract per kilogram of body weight daily.

Animals so treated remain in perfectly normal condition forty to fifty days, and can not be distinguished from normal unoperated cats. They eat, play, fight with one another and keep themselves sleek and clean. Most of our animals have shown weight increases during treatment. We have sacrificed several of our animals on the fiftieth day of survival in order to search for accessory adrenal tissue, but in no case have we found anything, despite the most exhaustive search.

In our earlier work with the lipid fraction which was injected in oil subcutaneously, considerable difficulty was experienced in keeping our animals much beyond forty or forty-five days, owing to accumulation of oil under the skin and abscess formation. The animals' coats became rough, the hair fell out in patches and their weight gradually declined. None of these difficulties have arisen in the experiments when the aqueous preparation of the original lipid fraction was employed.

The interesting point is that all healthy double operated animals survive and remain in normal condition when treated with the extract. Just how long cats so treated will survive we are unable to say at present, since our longest surviving animals are now in their eightieth day and in excellent condition. The experiments, however, justify the conclusion that we have successfully extracted from the suprarenal cortex of beef an active hormone which maintains the life of bilaterally adrenalectomized cats.

A detailed account of the various experiments will be published shortly.

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THE PRE-OLIGOCENE STRATIGRAPHY OF PORTO RICO

A recent geological survey of northeastern Porto Rico shows that the stratigraphic sequence suggested by Carlotta J. Maury in Science for December 20, 1929, needs emendation, at least so far as the formations which lie unconformably beneath the Oligocene-Miocene coastal plain are concerned.

According to Dr. Maury, rocks of Eocene, Upper Cretaceous and possibly Lower Cretaceous ages are present. She regards the La Muda limestone as one of the youngest pre-Oligocene horizons, placing it in the Upper Eocene; and a similar, if less precise, position was given it by D. R. Semmes in 1919[1] on the basis of a small and inconclusive micro-fauna. The writer's structural studies have developed the fact that the bed lies stratigraphically beneath the Upper Cretaceous formations which Maury calls the Fajardo and Cape San Juan limestones.

Both Maury and E. T. Hodge[2] believe that the limestone south of Cidra lies at, or near, the base of the Porto Rican section, and they both place it tentatively in the Lower Cretaceous. This formation, however, has been found to be the La Muda limestone, repeated on the flank of one of the several folds which rib the island. It lies neither at the base nor at the top, but slightly below the middle of the 10,000 to 11,000 feet of pre-Oligocene volcanics and sediments in this part of Porto Rico. The limited evidence available indicates that they are all Upper Cretaceous in age.

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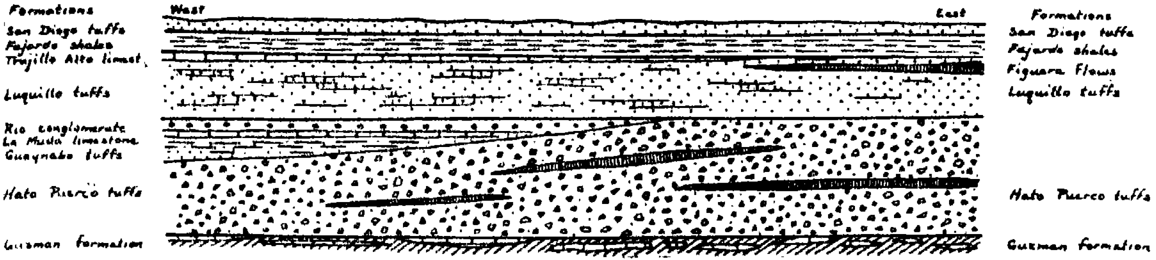
[1] D. R. Semmes, "The Geology of the San Juan District, Porto Rico," "Scientific Survey of Porto Rico and the Virgin Islands," Vol. I, pp. 74–75, 1919.

[2] E. T. Hodge, "The Geology of the Coamo-Guayama District, Porto Rico," *idem*, pp. 132, 192–198, 1920.



Vertical scale: 1 inch = 8,000 feet.

FIG. 1. Restored section of the Upper Cretaceous rocks between Bayamon and Fajardo, P. R.

It must be assumed that the designation of the rocks in the vicinity of Fajardo and Cape San Juan as limestones was an inadvertent slip, for the outcrops in this region consist of the Fajardo ashy shales and of a formation of stratified tuffs for which the name "San Diego" is herewith proposed. There are no limestones nearer than the valley of Rio Sabana, six miles to the west, where a thin wedge of the Trujillo Alto limestone is present.

The writer is not familiar with the structural and stratigraphic details in central and western Porto Rico, but the facts published suggest that some caution is necessary in formulating a geologic section which utilizes stratigraphic units from those portions of the island. Hodge placed the Rio Jueyes series in the Eocene on the strength of a single specimen identified as *Venericardia alticosta* Conrad,[3] and Maury apparently accepts his conclusion. Above the Rio Jueyes series lie the Coamo tuff-limestone and the Rio Descalabrado series, which both authors have necessarily referred to the Eocene. Yet, in the calcareous strata of this entire sedimentary series, which outcrops on the southern slopes of the Cordillera Central, G. J. Mitchell has reported abundant specimens belonging to the rudistid genus, *Radiolites*.[4] No better index fossil of the Cretaceous can be found, and in view of the presence of rudistids in the Rio Jueyes and Rio Descalabrado series, their assignment to the Eocene may well be questioned. The presence of Eocene rocks in any part of Porto Rico thus appears to be extremely dubious, although the possibility of their existence has not yet been completely eliminated.

At the present time the information in print is not adequate for the development of a stratigraphic succession that will apply to the pre-Oligocene rocks of the entire island. Determination of such a sequence is rendered triply difficult by the large intrusions which cut the section, by the complexity of the structure and by the baffling lateral gradation which some of the formations undergo. The accompanying restored section will illustrate the type of lateral change that occurs in northeastern Porto Rico within a distance of thirty miles. The geological age of the basal formation is not known; the others are Upper Cretaceous but do not include the highest members of the pre-Oligocene sequence.

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[3] *Idem*, pp. 193–194.

[4] G. J. Mitchell, "The Geology of the Ponce District, Porto Rico," *idem*, pp. 255–257, 1922.

THE PROPER TAXONOMIC CLASSIFICATION OF CERTAIN PYTHIACIOUS ORGANISMS

THE literature of mycology and plant pathology of the last few years contains many such phrases as "Pythium-like fungus causing this or that disease."[1] It is unfortunate to find in highly technical papers such expressions as the above, that tend to confuse rather than clarify the true taxonomic position of a group of organisms of great economic importance, since many of them are very aggressive plant pathogenes. This group of Pythium-like fungi is represented by such species as *P. gracile* Schenk,[2] *P. monospermum* Pringsh.,[2] *P. Butleri* Subram.,[3] *P. aphani-*

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[1] B. B. Branstetter, "Corn Root Rot Studies," Res. Bulletin 113, Agr. Exp. Sta. Univ. of Missouri, 1927; C. W. Carpenter, "Pythium in Relation to Lahaina Disease and Pineapple Wilt," *Hawaiian Planters' Record*, 23: No. 3, pp. 142–174, 1920; C. W. Carpenter, "Morphological Studies of the Pythium-like Fungi Associated with Root Rot," Hawaiian Bulletin Exp. Sta. Hawaiian Sugar Planters' Association, Bot. Series, Vol. 3, Part I, pp. 59–65, 1921; C. W. Edgerton, E. C. Tims and P. J. Mills, "Relation of Species of Pythium to the Root Rot Disease of Sugar-cane," *Phytopath.*, 19: 549–564, 1929; Helen Johann, James R. Holbert and James G. Dickson, "A Pythium Seedling Blight and Root Rot of Dent Corn," *Jour. Agr. Res.*, 37: 443–464, 1928.

[2] Alfred Fischer, "Die Pilze: Phycomycetes," pp. 383–410 in Rabenhorst's "Kryptogamen Flora von Deutschland, Oesterreich and der Schweiz," IV. Abtheilung, Leipzig, 1892.

[3] L. S. Subramanian, "A Pythium Disease of Ginger, Tobacco and Papaya," Memoirs of the Dept. of Agriculture in India, Bot. Series, Vol. 10, No. 4, 1919.

dermatum (Edson) Fitzpatrick[4] and *P. arrhenomanes* Drechsler.[5]

This group of organisms has been called "Pythium-like" because it possesses, on the one hand, certain likeness to the true Pythium organisms, and on the other, certain dissimilarities. Fischer[2] recognized this fact and created the subgenera Aphragmium, Nematosporangium and Sphaerosporangium, the first two to take care of the "Pythium-like" organisms and the last of the true Pythium organisms. Schröter[6] later divided the genus Pythium into the genera Nematosporangium and Pythium, the former including Fischer's subgenera Aphragmium and Nematosporangium and the latter only the subgenus Sphaerosporangium. The basis of differentiation between the genera Nematosporangium, Pythium and Phytophthora lies in the morphological difference existing in their zoospore-producing organs.

There are three morphologically different organs, the prosporangium, emission collar and zoosporangium. The prosporangium serves as reservoir of the protoplasm intended for the development of zoospores, and the zoosporangium for the full development and discharge of zoospores. The emission collar separates the prosporangium from the zoosporangium and serves for the passage of the protoplasm from the former to the latter organ. The wall of the prosporangium is a continuation of and identical with the exterior wall of the hypha supporting this organ, whereas that of the zoosporangium is not, but constitutes a part of the so-called ectoplast or protoplasmic membrane of the prosporangium. The zoosporangium is of short duration; it emerges from the emission collar almost simultaneously with the flowing protoplasmic contents of the prosporangium and lasts until the zoospores are completely formed and have escaped into the surrounding medium.

The three genera may be differentiated on this basis, as follows:

Nematosporangium: Prosporangia not well defined, nematoid, alantoid or rarely subspherical, intra- and extra-marginal; emission collar very long; zoosporangia spherical, size variable; zoospores few to many.

Pythium: Prosporangia well defined, spherical to ovoid, mostly extra-marginal, rarely intra-marginal; emission collar short; zoosporangia spherical, size variable; zoospores few to many.

Phytophthora: Prosporangia well defined, lemon shaped to spherical, mostly extra-marginal of different sizes; zoosporangia developing within the walls of prosporangia; emission collar entirely lacking or rarely slightly developed; zoospores few to many.

Furthermore, species of the genus Nematosporangium are differentiated by their rapid or slow production of oospores in culture media and tissues of hosts, by the filling or not filling of the oogonium by the size of oospore, number of antheridia and other characters.

Fitzpatrick[4] strongly recommended the adoption of the generic name Nematosporangium instead of Pythium in *Rheosporangium aphanidermatum* Edson, but unfortunately this recommendation has not been adhered to by more recent workers.

The writer, on the basis of extensive studies on all the well-known "Pythium-like" organisms or Nematosporangium spp., and, in addition, on eight more new species obtained from diseased pineapple roots, is absolutely convinced that the morphologic differences existing between the Nematosporangium organisms, on the one hand, and the Pythium ones, on the other, are sufficiently significant to merit generic distinction.

It is proposed, therefore, that those organisms, known heretofore as *Pythium aphanidermatum* (Eds.) Fitz., *P. Butleri* Subramanian and *P. arrhenomanes* Drechsler be renamed as *Nematosporangium aphanidermatum* (Eds.) Fitz. comb. nov., *N. Butleri* (Subram.) comb. nov. and *N. arrhenomanes* (Drechsler) comb. nov.

Such organisms as *Pythium gracile* de Bary, *P. dictyospermum* Rorciborski and *P. monospermum* Pringsheim have been placed already by Schröter in the genus Nematosporangium.

The writer is preparing a paper which will soon be published wherein eight new species of this genus are described and the taxonomic features of this genus are thoroughly discussed.

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BOOKS RECEIVED

EMELÉUS, K. G. *The Conduction of Electricity through Gases.* Pp. x + 94. 37 diagrams. Dutton. $1.10.

GODWIN, H. *Plant Biology.* Pp. ix + 265. 67 illustrations. Cambridge, Macmillan.

HUNTRESS, ERNEST H. *A Brief Introduction to the Use of Beilstein's Handbuch der Organischen Chemie.* Pp. v + 35. Wiley. $1.00.

STONER, EDMUND C. *Magnetism.* Pp. vii + 117. 20 diagrams. Dutton. $1.10.

WEATHERBURN, C. E. *Differential Geometry of Three Dimensions.* Volume II. Pp. xii + 239. Cambridge, Macmillan.

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[4] H. M. Fitzpatrick, "Generic Concepts in the Pythiaceae and Blastocladiaceae," *Mycologia*, 15: 166–173, 1923.

[5] Charles Drechsler, "*Pythium arrhenomanes* n. sp., A Parasite Causing Maize Root Rot," *Phytopath.*, 18: 873–875, 1928.

[6] J. Schröter, "Pythiaceae," in Engler-Prantl, "Natürliche Pflanzenfamilien," pp. 104–105, 1897.

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HONOR SOCIETIES[1]

By Dr. E. P. LYON

DEAN OF THE UNIVERSITY OF MINNESOTA MEDICAL SCHOOL

The other day a recent graduate of our school came in to see me. He had just completed his internship and was trying to decide whether to begin practice or to enter upon graduate study. Across his stomach—it was too low for his heart!—I observed a watch chain from which dangled four golden keys. There was Phi Beta Kappa. He was the best scholar in his class in a well-known college, and he hung that key on his chain when he took his A.B. degree. There was Sigma Xi. He gathered that in his second year of medicine by spending his spare time—oh, yes! a good man has spare time!—and his vacations in the bacteriological laboratory and writing a nice original paper. The third was Alpha Omega Alpha. Those present know how he got that. He stood second in his class in medical school, and the Minnesota Chapter took several dollars of his (father's?) money and presented him with the mystic emblem which goes Revelations one half better, for it says, "I am Alpha and Omega and Alpha over again." Finally there was the key of the licentiate of the National Board of Medical Examiners.

As I talked with this young man I remember thinking that each of those jewels stood for a good job of work. I knew he had earned each one of them. I also thought that each combination of Greek letters represented a motto—a phrase of admonition and guidance. And I thought, "This boy deserves his baubles, but I doubt whether he could tell in a single case what the letters stand for." And I thought, "What storehouses will those keys open for this man? Alas, they will open no locks. He will have to pick the locks. I think he can do it."

Just then one of his old classmates came in, hit my man on the back and scoffed: "O boy! Lamp the decorations! Looks like a row of anchors on the side of a battle-ship! Say, Saint Peter, you ought to get a key ring and carry those things in your hip pocket."

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[1] Delivered before the Alpha Omega Alpha Society, St. Louis University Medical School.

But the proud possessor of the keys of heaven—fortunately he has a sense of humor—retorted without turning a hair: "You poor moron! What do you know? I might have had a Phi Lambda Oop., but they cut me off because I said I was going to be a doctor and not a chemist. I'll give you the bunch if you'll tell me where there's a good place to hang out my shingle."

Of the making of honor societies there is no end. The list of them reads like the roster of radio stations —so many and so varied that one wonders that the abbreviated Greek alphabet affords sufficient combinations. One hears faculty tales that in one college at Minnesota there are enough honor societies to provide membership for every senior student with a "C" average, though, of course, it doesn't work out quite that way. One actually learns of a super honor society—I forget its lettering—which takes only the best of the members of the regular honor societies. One contemplates the possibility of an extra, ultra, paramount and preeminent society which will initiate only the upper 10 per cent. of the super society. One waits breathlessly for the formation of an honor society for those who fail to make an honor society. One is told of Fi Beter Capper, at an eastern university, whose standard is said to be that candidates must flunk three fourths of their courses and yet remain in school.

What does all this mean? Or does it mean anything? Is the honorary fraternity just a mutual admiration organization—an amusing and harmless association of those afflicted with a superiority complex? Or is the honor society—are some honor societies—representative of real superiority, perhaps hard to define and analyze but a complex and actual force?

I am not sure that we can answer these questions. Perhaps they can not be answered. But before we try to answer let us simplify the task by eliminating from consideration all those societies in which a social or personality factor affects the selection of members. Let us leave to the barber and cosmetic schools the bestowal of honors founded on the color of eyes or hair. Let us leave to the Blue Book and Social Register prestige founded on good fellowship and social graces. Let us even omit—but regretfully, for we shall lose persons high in public esteem—let us omit those societies which stress physical prowess, the athletic honor societies. Let us be old-fashioned enough to consider scholarship as the aim of higher education and include in our discussion only those societies whose sole criterion of membership is scholarship.

Also before we try to answer the questions let us be clear to start with that we do not imply too much. Membership in an honor society means that, in the judgment of some body of persons, one has stood above his fellows in some particular group and situation and in some particular respect. Phi Beta Kappa means high scholarship in an arts college among a group of arts college seniors. Alpha Omega Alpha means high scholarship in the subjects of the medical curriculum, under the conditions prevailing in a particular school. One can not expect a group chosen at this age and in these conditions to be fully correlative with a group which might be chosen after ten years' further development in contact with the world.

Furthermore, the judging of scholarship involves the comparison of marks and brings in all the shortcomings of the marking system. We know that no system of grading is completely dependable. If we arrange 100 men in order of scholarship marks, we know that number 1 is surely better than number 100 —better than number 50. But we are not at all sure that number 10 is better than number 11 or number 12. If we choose the upper 10 per cent. or 25 per cent. for an honor group we may reject some who ought to be included, may include some whom a perfect system would leave out.

This implies that reasonable humility is called for, and that we who wear the keys ought not to be too cocky in our attitude toward those who ornament their vests in some other way.

These errors in ranking students become greater when the comparison is made on the basis of an elective curriculum. For example, in the arts college, how is one to compare a student who majors in mathematics with one who majors in French literature? I have understood that there is more or less jockeying and more or less heartbreaking in Phi Beta Kappa elections because of interdepartment rivalry, particularly as regards the last and border-line cases under consideration. This may be less true in elections to Alpha Omega Alpha because of a more fixed curriculum. But to some extent a factor of uncertainty must always be there.

Note further that rank established by a comparison of marks is a judgment made on the cold facts of the record. It indicates just that and no more. Perhaps, however, number 10 on our imaginary list had all his time for study, whereas number 11 had to work for a living. Perhaps number 10 was well while number 11 had a sick spell. Under other circumstances their relative ranks might have been reversed. Nevertheless, the poorer man will always wear the key, and the other fellow must be content with a Red Cross button or join the Elks. There is no way of helping this situation.

Let us bear in mind, then, that elections to honor societies are subject like everything in life to fallible human judgment made on fallible human data.

Founded on averages for a large number of people, they represent fact. They are approximately correct for the limited situations and groups they cover, but not absolutely so as regards individuals. This may be some consolation for those who fail to get in and ought to exert a tempering influence on the superiority complex of those who make the honor group.

But going a step further let us assume that we have picked the upper 10 per cent. for an honor society and that they really are the top 10 per cent. They are the best men, the most intelligent, the steadiest workers. They deserve the honor. But what does it signify?

How much of their superiority did they make for themselves? Some, perhaps, but by no means all. They were born good. The honor by good rights should be shared with their grandparents. This seems certainly true for that part of our make-up spoken of in a limiting way as intelligence. It seems probable that it is true in considerable degree for the indefinite qualities sometimes called temperament. That one man works harder than another, has more ambition, is less easily discouraged, is able better to "put it across," has better health and more strength—all these may be partly hereditary.

The business instinct which caused the servant who received five talents to put them into trade and gain other five talents may have come from his father as truly in a material sense as the five talents of capital with which he began his financial operations came from his master. Perhaps he got it, as in a purse, included in the chromosomes of the parental sex cell. And the lack of imagination and initiative which caused the one talent servant to hide his money in the earth may just as truly have been inherited—doubtless from the maternal side of the house!

I am not belittling the influences of environment. I am not saying that education is futile. I am not maintaining that the formation of useful habits—whether of study or in other directions—is not to be striven for and is not immensely valuable when acquired. I am saying that in selecting any superior group a large hereditary factor comes in. Personally I believe it is the largest factor. Anyway it is a large factor. And admitting this, it behooves the wearer of keys to be moderately humble and take a short course in ancestor worship.

And now to proceed one step further in the debunking of our own group, Alpha Omega Alpha, what can be said on the proposition that election to this society is a prophecy of success in the practice of medicine? Does the brilliant man make a better doctor than his less well-endowed classmate?

A few years ago I should have fallen back on my favorite doctrine of averages. I should have said there will be some lack of success among the brilliant top men and there will be many successes among the much larger number of the average and poor men. But a larger share of the upper 25 per cent. will succeed than of the lower 75 per cent.

But gradually I changed my mind. I was impressed more and more that success in the practice of medicine depends largely on qualities which the classroom and examination do not reveal or test. These qualities are sometimes heaped together under the head of personality, sometimes opprobriously denominated "salesmanship." (Yes, it is a fact that a doctor must be able to sell himself before he can serve.)

He must be able to create confidence. He must be able to get the sick man's point of view. He must—or at least, should—have a sympathetic attitude. He must be able to mingle on a basis of mutual interest with all classes of people. He must minister to his patients. He must be a *minister!*

So true is this that I have sometimes characterized the practice of medicine as 50 per cent. science, 50 per cent. skill in technical procedure and 100 per cent. ministry! A 200 per cent. man—that is a good doctor!

Whatever you call that extra 100 per cent.—that indispensable, intangible, psychological something that makes a good doctor—our methods of choosing medical students take it very little into account. Our curriculum and teaching methods do not measure it or in large degree, I think, develop it. The graduate has it or has it not, finds it or does not find it, owing to influences beyond our knowing or, at any rate, beyond our immediate power to gauge and direct.

Now if a large part of one's qualification for making a success in the practice of medicine is beyond the purview of those who select the members of our honor group, you will not be surprised—nor was I—to learn that the successful men in medicine come about equally from those who stood in the upper, middle and lower thirds of their medical school classes. The survey was made by the Commission on Medical Education and included over 1,600 physicians. These were judged successful by fellow practitioners. The criterion was not financial but rather sound medical practice—good service to the people—which, you are aware, is a thing that fellow members of the craft know but which patients unfortunately do not know.

So, if the members of Alpha Omega Alpha here present have foreseen themselves successful beyond the average of their classmates, if they have envisaged crowded waiting rooms and a multitude of grateful patients, this is the time to debunk; this is the time to deflate. Apparently they will get no more of that form of success called success in medical practice than their key-less companions.

But now that we are all prostrate and reduced to the common level—let us key wearers reexamine our position and try to find out just what bulwarks and ammunition we have. It may be that the honor societies are justified after all.

Let us look at the history of a few of them.

Phi Beta Kappa is by far the oldest, having been founded in 1776. For more than fifty years it was a secret fraternity like the others we know so well, of which it was the first. In fact, all the rest are imitations of early Phi Beta Kappa. In 1831 it gave up its "secrets." Gradually it perfected its system of election until now it is practically speaking a scholarship honor society in arts colleges.

How do the members of Phi Beta Kappa show up in later life? I suppose no statistical study of the success of Phi Beta Kappa men in contrast with those college graduates who are not members has ever been made. But the list of great ones in the society is impressive. I quote from their booklet: "Eight have been chosen to the Presidential office. . . . The Chief Justice and four Associate Justices of the Supreme Court are Phi Beta Kappa men. A great host of them adorn the learned professions. Others are noted scientists." A copy of the *Phi Beta Kappa Key* recently before me is largely taken up with accounts of the installation of Phi Beta Kappa men as college presidents. Eight new presidents are listed in that particular number of the *Key*. One, Dr. Arthur Stanley Pease, was installed at Amherst, and the account of his inauguration modestly stated that all presidents of Amherst from 1821 to date, ten in number, have been Phi Beta Kappa members.

Yes, the *Key* does a nice job of advertising! But there can be no doubt that this honor society has among its members a very large number of persons who have become successful in callings requiring intelligence and scholarship. It does select a superior group.

Parenthetically, it must be said that it does not—can not—get *all* the good and great. How could it? It confines its membership to arts college graduates. At Minnesota high-grade graduates of the nearly related College of Education are not eligible. Moreover, not all good colleges have chapters. Hoover, as an engineering student, would not have been eligible even if there had been a chapter at Stanford when he graduated. And the Happy Warrior, poor fellow—he can never join a "frat," never wear a lettered sweater, never sport a key. Yet some of us think his cerebrum is a rather unusual and effective piece of architecture.

Ibsen calls the great of the earth—I have the quotation from a book of Hamlin Garland's—"an aristocracy of mind, of character and of will." Phi Beta Kappa includes among its members a goodly number of this nobility but by no means all. Nor should we think that all the aristocracy of medicine will wear the key of Alpha Omega Alpha. There are good fish that do not get into the net. Furthermore, as I indicated earlier, quite a few medium-sized fish get their gills entangled in the meshes during the fishing operations.

(This is the last debunking I shall do. Hereafter, Alpha Omega Alpha, you may raise your head, proud though somewhat battered about the eyes.)

And returning to Phi Beta Kappa let us ask what else the society has accomplished. Apparently customs differ among the chapters, but a frequent thing has been the support of annual addresses on appropriate topics by some of the country's best thinkers. Some of these addresses have been published by the society. Delving into the volume before me I note orations by such men as Ralph Waldo Emerson on "The American Scholar," George William Curtis on "The American Doctrine of Liberty," Wendell Phillips on "The Scholar in a Republic," Charles W. Eliot on "Academic Freedom," Woodrow Wilson on "The Spirit of Learning."

From Wilson's address I cull the following:

> What we should seek to impart in our colleges . . . is not so much learning itself as the spirit of learning. It consists in the power to distinguish good reasoning from bad, in the power to digest and interpret evidence, in a habit of catholic observation and a preference for the non-partisan point of view, in an addiction to clear and logical processes of thought and yet an instinctive desire to interpret rather than to stick in the letter of the reasoning, in a taste for knowledge and a deep respect for the integrity of the human mind.

I do not know of any better formulation of the general aims of our medical schools or the aims of Alpha Omega Alpha than these sentences by Woodrow Wilson. If he had used the expression "scientific spirit" you would all see that this is true.

We will admit, then, that Phi Beta Kappa in fostering its annual addresses has done something fine and worthy of imitation.

According to members of the Minnesota faculty the competition for Phi Beta Kappa is a salutary influence among undergraduates. One infers that the good effects are found both among those who are elected and among those who fail to make the fraternity. The boy who fails to get a key may be heartbroken at the time, but he has acquired the better thing—the habit and love of study. One opines that anything which stimulates a desire for scholarship in these days of extracurricular activities and of sentiment against serious study is to be commended.

We have made, it seems, a good case for Phi Beta Kappa; and those who have its emblem may now polish it up and restore it to a prominent position over the abdomen. With lapse of years adipose will collect there and tip the key more and more into the line of vision of colleagues and neighbors.

Sigma Xi is the next I shall mention. It was founded at Cornell in 1886 with the intention that it should be a scientific Phi Beta Kappa. Sigma Xi now has forty-five chapters. It has become more representative of productive scholarship than the older society. Its motto means "Companions in Zealous Research." Seldom, if ever, is membership granted on the basis of excellence in science courses alone. An original publication or evidence of investigative ability is required.

I consider that it is a great honor to a young man or woman to be admitted to Sigma Xi. I think that earnest striving for this honor has helped a good many students to grow. I wish high-grade medical students would oftener do the research work which would make them eligible to this society. It would stimulate able students in science methods and scientific thinking; and even if they did not become investigators, they would be better doctors.

Sigma Xi as an organization fosters activities quite similar to Phi Beta Kappa. Its annual addresses are on scientific subjects, and not a few of them have been distinguished.

The society and its individual chapters have helped research and aided in the spread of the scientific spirit in a variety of ways. There is quite an extensive literature on this society. If you have a Sigma Xi key, polish it up and put it out in front.

I might, if time permitted, refer to three or four other societies which are worthy of high rating. But now I must go on to Alpha Omega Alpha, the society under which this meeting was promoted and of which many of us are members. We may have plucked a few feathers out of its war bonnet, but we are proud of our tribe none the less.

This fraternity was founded in 1902 at the College of Physicians and Surgeons, Chicago, now the Medical School of the University of Illinois. The founder was William W. Root, a senior. Eight others with Root were charter members. It was purely a student movement. Not until later did faculty members have a hand in the organization.

It was a time of low standards in medical education—eight years before the famous Flexner report. There were about 160 medical schools in the United States—twice as many as now. Many of these were purely commercial in character. The standard of admission in almost all schools was nominally high-school graduation, but really lower. The schools advertised and proselyted in a shameful manner. The unsavory traditions of medical school life were intensified by a liberal sprinkling of uncouth and rowdy students. You who are accustomed to the average reasonably high culture and decency among medical students now would not have been at home among those who studied medicine twenty-five years ago. I remember when I went to St. Louis University Medical School in 1904 they killed all my frogs by spitting tobacco into the aquarium. They were a rough but jolly lot.

Character is a difficult thing to judge in the absence of "overt acts," but probably the common impression is correct that there were more drinking, sex irregularity, cheating and general dishonesty than among a similar group now. At any rate they were louder about it.

At Physicians and Surgeons Root and his companions undertook a "positive stand for better things." Their ideals included not only good scholarship but honesty and decency— in a word, character. Of course they could have had in mind no picture of what their little effort would grow into. But the germs of the present society were in the ideals of that group of seniors at the old P. and S. Root states that the first meeting was in the bacteriological laboratory. Perhaps there was prophetic significance in the presence of culture media and incubator. Just imagine what might have followed if the society had been born in the pathologic department!

Whatever may have been the external influences, there can be no doubt as to the viability of Alpha Omega Alpha's germ-plasm. In two months there was a chapter at Rush; a little later, one at Northwestern. There are now thirty-six chapters. So far as careful judgment can determine they are in the best medical schools of the United States and Canada. The society represents an honor group of colleges as well as of individuals.

While the original idea was wholly of student origin, the society owes much to faculty advice and help. Professor Winfield Scott Hall, of Northwestern, and Professor Walter B. Cannon, of Harvard, are two to whom the organization owed much during the formative period.

It is particularly enjoined by the constitution that "unpopularity of a student shall not be a bar to his election." Further, no student may be rejected on character grounds without a full statement of reasons and, presumably, of evidence. The motto means "To be worthy to serve the suffering." The key has an anatomical significance. The initiation consists of no more than the affirmation of the Oath of Hippocrates and the signing of the constitution. Usually there are explanatory remarks concerning the history, constitution and aims of the fraternity, by some faculty member.

Just as the Oath of Hippocrates is to be observed not as literally applying to present-day medicine but rather in the spirit, so the force of Alpha Omega Alpha lies not in the formal organization but in its ideals. These again are but the highest ideals of the honorable profession to which you all expect to belong, with the addition of the desirable but not always attainable ideal of high scholarship. It may be said, therefore, that any physician who serves his patients according to the highest canon of the profession is an Alpha Omega Alpha in essential spirit.

The society merely marks or strives to mark those of the greatest intellectual capacity—as I have before said. It is a part—a part only—of the "aristocracy of mind, of character and of will." This aristocracy is largely, as I have remarked, as truly hereditary as any feudal nobility—only this one is governed by the laws of biology rather than those of primogeniture. The only common law is that of *noblesse oblige.*

Noblesse oblige—obliges what? Obliges all, it seems to me, that superior talent, character and will can accomplish. Obliges from the organization standpoint all that the united group can bring about for the common good of the profession in which this aristocracy exists. It should strive for better medical education, better teaching, fuller medical knowledge, better medical practice, better medical service for all the people, better public health, better understanding and respect for medicine and doctors on the part of the public. In these directions the society as a national unit and as chapter groups is moving.

Like the previously mentioned societies Alpha Omega Alpha has fostered annual addresses, usually before large audiences of medical men. Some of these have been distinguished contributions. Certain chapters have offered prizes for original investigation. Some have started loan funds for needy students. Some have conducted lecture courses or formal programs similar to those of medical societies. One at least has assisted the library of the school in which it is located. One has organized as a research club. One inaugurated tuberculosis clinics in a neighboring city.

There are many valuable things which a chapter can do. No chapter should be content with only an annual meeting, banquet and initiation.

All chapters, so far as I know, have exercised a stimulating influence on undergraduate scholarship. Inquiring into this matter I have met the suggestion that the influence would be greater if efforts were made to call the attention of freshmen and sophomores to the existence and aims of the society. One chapter offers a prize for the best student in the sophomore group. I pass these suggestions on to the local chapters.

Noblesse oblige—and what of the individual member? Surely to use his God-given ability to the fullest. "An aristocracy of mind, of character and of will." Woe to him who falls down on the last of the trilogy. Woe to him to whom the stimuli to highest achievement he had while in school fail when he gets away from the bracing atmosphere of the educational environment. He must become self-sufficient, self-starting. He must supply his own stimuli. "The sin I impute to each frustrate ghost is the unlit lamp and the ungirt loin." And sinner of sinners is he who lets his lamp, once lighted, go out, and drops the mantle once girt about his loins.

But more specifically and in conclusion, I think we must look to Alpha Omega Alpha for a large part in the progress of medical science. I think a goodly portion of the new and useful knowledge during the coming years will come from the members of this society. I think that in larger ratio than its membership indicates it will supply the medical teachers, writers, investigators and those who while in active practice make noteworthy contributions to medical knowledge and medical literature.

And why do I think so when I have told you already that you may expect only your proportion of the successful medical practitioners? Because I think that those qualities which make the teacher or investigator are the ones which scholarship signifies and this society represents.

The successful doctor needs a good but not a superior intelligence. The situations he faces, the associations of ideas he is required to make, the judgments he is called upon to pronounce are usually familiar situations, associations, judgments. It takes only reasonable ability and knowledge now to pilot a ship across the Atlantic. It took a genius in the day of Columbus. Almost any reasonably intelligent doctor with some technical skill can do now what McDowell or Marion Sims did. It took supermen to do it the first time.

The characteristic of high intelligence is the ability to make new associations, the ability to see new ideas and new arrangements or relations of ideas. The characteristic demand of research is first for new observation; but more, for new associations of new or old observations and for new methods. The research man is he who knows what to look for. The research man is he who sees what he isn't looking for. The research man is the one like Claude Bernard or Jacques Loeb who capitalizes his failures. These qualities go with the keenest intelligence.

I honestly believe, members of Alpha Omega Alpha, that another generation will see a large majority of he professorships in medical schools, the directorhips and other posts in research institutes, the editorhips of medical journals held by those who as underraduates were elected to Alpha Omega Alpha. New methods and instruments and diseases will be named for you. The author's index in medical literature will be, in large degree, an A. O. A. directory. The text-books will bear your names. The handbooks of research will contain your biographies. You will even be mentioned in "Who's Who," which is almost as bad as having a pyramid named after you.

Medical practice needs good men. Medical practice is an honorable and useful calling. But I believe that teaching and research need men of A. O. A. caliber even more than the practice of medicine needs them. I direct your eyes to the immensity of the unknown. I parody Browning:

Contrast
The petty Known, the Unknown vast.

Bring your great talents, Alpha Omega Alpha, like Columbus to the shore of the unknown. Chart new pathways, sound new depths, dare new winds and currents, visit strange lands, bring back new fruits—then shall ye be great. Then shall ye be dukes and kings in the aristocracy of intellect. Then shall ye deserve your heritage—and your key.

OBITUARY

RICHARD MILLS PEARCE, JUNIOR

Dr. Richard Mills Pearce, Jr., died on February 16, 1930, of heart disease. Born in Montreal on March 3, 1874, he received his early education at the Boston Latin School. Taking up the study of medicine, he entered the Harvard Medical School, from which he received his medical degree in 1897. After graduation there he came under the influence of Professor W. T. Councilman, and entered the department of pathology, where for a year he filled the position of instructor.

In 1900 Dr. Pearce was called to the University of Pennsylvania, becoming first demonstrator in pathology and, later, assistant professor of pathology. In 1903 he assumed the directorship of the Bender Hygienic Laboratory, in affiliation with the Albany (N. Y.) Medical College, in which latter institution he held the professorship of pathology and bacteriology. Five years later he became professor of pathology in the New York University and Bellevue Hospital Medical College, New York City. In 1910 he returned to the University of Pennsylvania, to fill the newly founded chair of research medicine, and thus became the first research professor in medicine in the United States. During the World War, Dr. Pearce gave valuable services with the American Red Cross in Washington as secretary of the Medical Advisory Committee and director of the Bureau of Foreign Medical Service, and later with the National Research Council as chairman of the division of medicine and related sciences. At the conclusion of the war he resumed his temporarily interrupted research work at the University of Pennsylvania. During three years of personal association with Dr. Pearce at the University of Pennsylvania, the present writer was able to appreciate his competence, talent and devotion both as teacher and as investigator.

In the course of his teaching and research, Dr. Pearce's own contributions to scientific knowledge in pathology were significant. He made real additions to the knowledge of cytotoxins at a period when that subject was in the formative stages of its growth, and, correcting current errors, diverted experiment into more accurate channels, through which distinct progress came to be made. With the aid of his pupils he carried through one of the comprehensive and substantial investigations of the pathology of the spleen, and embodied the results in a volume of permanent interest. In addition to these, which may be regarded as his major undertakings, he successfully investigated, either alone or with or through pupils, numerous other problems in pathology.

In 1920, Dr. Pearce entered upon activities through which he was soon to be known and respected in wider fields; he became associated with the Rockefeller Foundation, carrying out at first medical surveys in South American and other countries; in 1923, he became regularly attached to this foundation as director of the Division of Medical Education, which position he held up to the time of his death. The field was not new to Dr. Pearce; he had in 1912 delivered the Hitchcock Lectures at the University of California on the subject of "Research in Medicine,"[1] in which he had forcibly and lucidly discussed the historical and present-day problems of medical education and research. His association with the Rockefeller Foundation led Dr. Pearce to investigate personally the state of medical education in many parts of the world, and to devise means through which medical teaching and research might be advanced by judicious financial assistance. He made many visits to foreign countries, including a long stay in China, in order to assist in the organization of the Peiping Union Medical College, in addition to numerous visits to medical institutions in the United States and in Canada. In the course of these studies, Dr. Pearce's constructive mind found out ways of modifying and improving existing conditions, and the warmth with which his suggestions were welcomed by the institutions under examination was shown by the frequency with which they were put into practice. It is not too much to say that Dr. Pearce's insight, high purpose, and tactful approach made his visits to educational institutions in many countries important events in their history. His services to them, conceived broadly as educational, were something apart from any material aid which he might bring them, although it sometimes happened, of course, that the developments which he foresaw could only be brought to fruition through financial aid.

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[1] Printed in "Medical Research and Education" by Richard M. Pearce and others. The Science Press, New York, 1913.

There can hardly be a doubt that an essential part of Dr. Pearce's success in perceiving ways of extending and improving facilities for medical education and research arose from his own dominant interest in medical research and his personal contributions to medical knowledge. During the whole of Dr. Pearce's laboratory career, which extended from 1900 to 1923, or more than twenty years, he was engaged himself, or with pupils, in teaching and in conducting medical research. This experience was of inestimable value to Dr. Pearce in his subsequent highly onerous and influential position as an officer of the Rockefeller Foundation, and to it may be traced those courageous, comprehensive projects in the enlarging of facilities for instruction and research in many places in the United States and Europe.

Dr. Pearce possessed a winning personality which brought him many friends and admirers. The nature of his educational activities in the later years gave an almost world-wide scope for the operation of his personal gifts. His heart was deeply immersed in these activities, and he felt the burden of the critical position which he came to occupy because of the declared purpose of the Rockefeller Foundation to contribute toward the improvement of medical teaching and research on a world-wide scale, an undertaking vast and intricate in nature. But it is doubtful whether in his heart of hearts the laboratory ever ceased to beckon to and allure him. This secret, if secret it be, was known to at least a few of his intimate professional friends. Possessed as Dr. Pearce was of clear perception and rare courage, he must have repeatedly put these longings behind him because of a conviction that perhaps after all he might serve an even wider purpose and accomplish greater good by making possible higher levels of education, and by providing better means of research to countless students in time to come in the many institutions to which financial aid could be brought through his efforts.

The death of Dr. Pearce means the loss of one who had been a notable teacher, investigator and finally supporter of medical education and research; but it is certain that the benefits of his effective labors will continue to be widely felt for very many years.

Simon Flexner

The Rockefeller Institute
for Medical Research,
New York

SCIENTIFIC EVENTS

AN AFRICAN MAMMAL HALL FOR THE MUSEUM OF THE CALIFORNIA ACADEMY OF SCIENCES

Mr. Leslie Simson, retired mining engineer and capitalist, of Berkeley, California, has sailed from New York for Mombasa, British East Africa, for the purpose of securing specimens of animals for habitat groups of African big-game animals for the California Academy of Sciences. Mr. Simson expects to collect the animals necessary for forty to fifty habitat groups, which will be installed in the Leslie Simson *African Mammal Hall*, which will constitute one of the most important units of the east wing of the academy's museum in Golden Gate Park, San Francisco. Construction work on the new wing will begin this summer, and it is expected that the building will be completed in 1931. The plans provide a hall or halls ample for housing and proper display of fifty or more habitat groups of large size similar to those in the present California Mammal Hall in the museum.

Mr. Simson lived in Africa for thirty-one years, associated with John Hays Hammond in mining operations. During his long residence there he did a great deal of hunting and became very familiar with the habits and the habitats of practically all the species of big-game animals of Africa.

Mr. Simson will at first make his headquarters at Nairobi, Kenya; later he will go to other big-game centers until he has secured a good representation of the species of big-game animals of Africa.

Upon his arrival at Nairobi he will begin his hunting at once, and he expects his first shipments of animals to reach San Francisco not later than next September. It is Mr. Simson's desire to provide the California Academy of Sciences with a series of habitat groups of African mammals second to none in America. His offer of materials and money to the academy should make this possible. He estimates that it will take about three years for him and his assistants to do the collecting.

THE SECOND BERMUDA OCEANOGRAPHIC EXPEDITION

The thirteenth expedition of the Department of Tropical Research of the New York Zoological Society under the directorship of Dr. William Beebe will leave for Nonsuch Island, Bermuda, on April 9.

The work this season will be a continuation of that begun last year—a detailed study of the fishes of shallow water, mid-depths and down to a mile in the open ocean. The tug *Gladisfen* has been rechartered for the season, and the deep-sea work will be confined to the submarine, cylindrical area selected last year. This zone is five miles south of Nonsuch, eight miles in diameter, and extends from a half mile to a mile beneath the surface. Within this watery space five hundred and twenty-eight nets were drawn in 1929, and it is hoped to increase this to one thousand during the present season.

As an example of the unexpected wealth of deep-sea fish life, the family Myctophidae may be cited. In 1929 there were captured in this sharply delimited area fifty-one per cent. of all the species of Myctophids or Lantern Fishes known from the seven seas, and eighty-seven per cent. of those hitherto known from the north and south Atlantic Oceans. These were distributed among four thousand, one hundred and sixty-one individuals.

Besides the intensive trawling with meter nets as last year, some bottom dredging with the seven-ton *Arcturus* winch will be done. With the aid of the same winch and with the spherical, steel diving chamber planned and financed by himself, Mr. Otis Barton will attempt to descend to a depth of a quarter of a mile. One of the chief objects of the expedition is to determine the continuity of benthontic fish life which connects the mid-water zone of one hundred fathoms with that of the ocean's floor two miles down. It is hoped that Dr. Harvey will continue his studies of luminescence in fish and crustaceans, and that Dr. Conklin will work on the early development of Amphioxus. Dr. Gregory and Dr. Fish will both spend some time at the station. As last year, the present expedition is made possible by the generosity of two members of the board of managers of the Zoological Society, Mr. Harrison Williams and Mr. Mortimer L. Schiff.

Besides the regular staff of the department, Beebe, Tee-Van and Hollister, a number of young college men will be taken, who will help in general activities and carry on special lines of research. Among these are S. Thomas, J. Cannon, J. Guernsey, P. Crouch, J. H. Conneny, J. Potter, W. C. Buhlman and P. Jackson. Three artists who did most excellent work last year at the station—Helen Tee-Van, Elsa Bostelmann and Llewellyn Miller—will spend part of this season in the field.

THE MEDAL AWARDS OF THE AMERICAN GEOGRAPHICAL SOCIETY

An announcement of the medal awards of the American Geographical Society for 1929 and 1930 appears in the April number of the *Geographical Review*. These awards have not been made for several years "in order that accumulated funds would make it possible to award them to distinguished persons of different nationality in a given year." The list of awards with citations follows.

Award of the Cullum geographical medal for 1929 has been made to Hugh Robert Mill, Jean Brunhes, Alfred Hettner, Jules de Schokalsky. The Cullum geographical medal is awarded from time to time to those "who distinguish themselves by geographical discoveries, or in the advancement of geographical science." The last awards were made in 1925.

Hugh Robert Mill. Geography is under a heavy debt to Dr. Mill for researches in his special field and writings on a wide range of geographical topics, all resting on a sound physical basis. As he himself has expressed it, his researches have been largely directed towards the discovery of the control exerted by the various forms of the earth's solid crust upon the fluid envelopes. Dr. Mill was director of the British Rainfall Organization and editor of *British Rainfall* and *Symons's Meteorological Magazine* for many years. He has filled various offices in the Royal Meteorological Society and the Royal Geographical Society and has served on the International Council for the Study of the Sea. Educational geography has profited from his writings; and he has always had a special interest in the polar regions, particularly the Antarctic. He is chairman of the board of directors of the Captain Scott Polar Research Institute.

Jean Brunhes. The name of Jean Brunhes, professor of geography at the Collège de France, is one with "La géographie humaine," one of the outstanding geographical works of our time. Translated into English it has had a profound effect upon American geographical teaching and point of view. Professor Brunhes is also known for his volume on the human geography of France contributed to the "Histoire de la nation française" and his collaboration with Camille Vallaux on the "Géographie de l'histoire." The government of France has sought his advice and assistance in studies and recommendations relating to the French colonies in the Far East and in Africa.

Alfred Hettner. As professor of geography in the University of Heidelberg, Dr. Hettner has exercised great influence on the development of geography in Germany, especially regional geography. In this he has been particularly aided by the *Geographische Zeitschrift*, one of the leading critical geographical journals, of which he is founder and editor. As a young man Hettner carried out important explorations in South America. "Russland" and the "Grundzüge der Ländeskunde," to mention two of his numerous writings, are model works of their kind, and a special word must be reserved for his book on methodology.

Jules de Schokalsky. Dr. Schokalsky is professor of oceanography in the Leningrad State University, president of the Russian Geographical Society and corresponding member (meteorology) of the Russian Academy of Sciences. His voluminous writings have been mainly in the fields of oceanography, hydrography and cartography. In the last named he compiled what is now the standard general map of Russia, a map in sixteen sheets on the scale 1:2,000,000. In 1917 he published a treatise on oceanography which is the crystallization of his previous work along those lines. He has recently undertaken a comprehensive survey of the Black Sea.

Award of the Charles P. Daly gold medal for 1929 has been made to Filippo De Filippi and Émile Félix Gautier. The Charles P. Daly gold medal is awarded from time to time "for valuable or distinguished geographical services or labors." The last award was made in 1927.

CAV. FILIPPO DE FILIPPI, secretary-general of the International Geographical Union, has done distinguished work in exploration. He accompanied the Duke of the Abruzzi on expeditions to Mt. St. Elias, in the Karakorum, and to Mt. Ruwenzori. Realizing the "variety and the importance of the problems as yet unsolved" in the Karakorum region, he organized an expedition of his own in 1913 and by the aid of a group of specialists carried out some remarkable work in geology, physical geography including glaciology, and human geography in the mountains and plateaus between the Vale of Kashmir and Chinese Turkestan.

ÉMILE FÉLIX GAUTIER. For a quarter of a century Professor Gautier, of the University of Algiers, has devoted himself to geographical investigations in northern Africa and the Sahara, on which regions he is a recognized authority. His writings, distinguished by characteristic ease and originality, reveal the intimacy of his knowledge in his chosen sphere.

CELEBRATION OF FIFTY YEARS OF ENGINEERING PROGRESS BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

THE Fiftieth Anniversary of The American Society of Mechanical Engineers will be celebrated in April in Washington, in Hoboken and in New York. The leading scientific and engineering societies and educational institutions throughout the world have been invited to send two delegates each to the celebration. Similar invitations have been extended to the leading trade associations and trade schools of the United States.

The celebration will open on April 5 in New York, where the delegates, members and guests will register at the United Engineering Societies Building. This will be followed by the unveiling of a tablet in the lobby of the building commemorative of the anniversary, and then the whole party will be taken to the offices of *The American Machinist*, a program being given that depicts the preliminary organization meeting on February 16, 1880.

The anniversary program will be continued at Stevens Institute at Hoboken, N. J., commemorating the organization meeting in the auditorium of the institute with a pageant of engineering progress which has been written by Dr. George Pierce Baker, of the department of drama, Yale University, and which will be presented by the institute under his direction.

At 7:30 p. m. will be given at the Hotel Roosevelt in New York a welcoming dinner under the auspices of the metropolitan section of the society. The toastmaster is Charles M. Schwab, an honorary member and past-president of the society. An address of welcome will be given by the president of the society, Charles M. Piez. There will be two other speakers—James H. McGraw, chairman of the board of the McGraw-Hill Publishing Company, who will represent the engineering press, and Robert I. Rees, president of the Society for the Promotion of Engineering Education, who will represent the field of engineering education.

On Sunday morning at eleven o'clock there will be commemorative services at the Cathedral of St. John the Divine in New York City. During that afternoon and evening departure will be taken for Washington, D. C.

In Washington, April 7, on Monday morning at eleven o'clock in the National Council Chamber of the U. S. Chamber of Commerce Building will be held the welcoming assembly. Addresses will be given by a representative of the government of the United States and by the president of the society, Charles Piez. There then will follow brief addresses by a delegate from each country in behalf of all the delegates from his country; by the presidents of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers and the American Institute of Electrical Engineers. Palmer C. Ricketts, president of Rensselaer Polytechnic Institute, will speak in behalf of American engineering educational institutions; William Butterworth, president of the Chamber of Commerce of the United States, in behalf of business organizations of the United States, and then a delegate in behalf of various American scientific and professional societies.

In the afternoon there will be a session on the Influence of Engineering upon Civilization, when seven of the sixteen national papers covering the humanistic aspects of engineering will be summarized in short addresses. This will be followed by a reception at the White House, while in the evening a reception will be given by the officers and council of the society.

On Tuesday the second part of the session on the

Influence of Engineering upon Civilization will be held when the remaining nine national monographs will be presented. There will be an address summarizing "Fifty Years of Mechanical Engineering in the United States." At noon a luncheon will be given in honor of the founders of the society and this will be followed by the ceremonies attendant upon the presentation of medals of distinction.

Fiftieth Anniversary Medals will be conferred upon the sixteen men who present the monographs. The formal presentation will be made in each case by the Ambassador in Washington of the country sending the delegate. This occasion has been deemed unusually appropriate for the presentation of four other medals—the American Society of Mechanical Engineers, the Gantt, the Melville and the Guggenheim, to William Leroy Emmet, Fred J. Miller, Joseph Wickersham Roe and Orville Wright, respectively. This particular part of the exercises will be in charge of Dr. Arthur M. Greene, Jr., dean of engineering at Princeton University.

At a formal dinner on Tuesday evening at which Dr. W. F. Durand, past-president of the society, will preside as toastmaster, there will be addresses by the president of The American Society of Mechanical Engineers, and by Dr. Robert A. Millikan, past-president of the American Association for the Advancement of Science. There will also be an address by a distinguished American that may include, from an international view-point, an evaluation of the influence of engineering in promoting international amity and upon the progress of mankind.

On Wednesday, April 9, the delegates will visit points of interest in Washington and vicinity.

The announcement and first presentation will be made of the Herbert Hoover Medal by the Hoover Medal Board representing the A. S. C. E., the A. I. M. E., the A. S. M. E. and the A. I. E. E.

SCIENTIFIC NOTES AND NEWS

Mr. John W. Davis, formerly United States Ambassador to Great Britain, will preside at a dinner of the American Philosophical Society to be held in New York on April 2 under the auspices of the New York members of the society. The speakers will be Sir Robert Falconer, president of the University of Toronto; Dr. Livingston Farrand, president of Cornell University; Roland S. Morris, formerly ambassador to Japan.

Professor Albert A. Michelson has returned to the University of Chicago, his health much improved after two months spent in Bermuda. He intends to remain at Chicago for several months, working in the Ryerson Physical Laboratory, and then plans to go to California to continue his measurements of the velocity of light in a mile-long vacuum tube.

Dr. Karl Landsteiner, a member of the Rockefeller Institute for Medical Research, New York, was awarded on March 14, the anniversary of Ehrlich's birth, the Paul Ehrlich gold medal of the Paul Ehrlich Foundation of Frankfort-on-the-Main, in recognition of his work on human blood groups and his hapten theory of immunity.

Dr. Robert Doerr, professor of hygiene at Basle, has been awarded the Josef Schneider gold medal by the University of Wurzburg.

The *Journal* of the American Medical Association reports that Professor Carlo Comba, director of the pediatric clinic of Florence, was the recipient of special honors on the twenty-fifth anniversary of his teaching activities. Professor Fiore presented his former teacher with a volume of scientific articles published for the occasion. Professor Comba has given the university 100,000 lire ($5,263) for a research fellowship in pediatrics.

We learn from *Nature* that at a meeting of the Royal Society of Edinburgh, held on March 3, the following were elected fellows: Professor William Annan, Edinburgh; Mr. D. R. R. Burt, Colombo; Lieutenant-Colonel John Cunningham, Edinburgh; Lieutenant-Colonel L. M. Davies, Edinburgh; Dr. A. E. M. Geddes, Aberdeen; Dr. Douglas Guthrie, Edinburgh; Sir Thomas Holland, Edinburgh; Dr. David Jack, St. Andrews; Dr. S. G. Jones, Glasgow; Professor P. S. Lelean, Edinburgh; Dr. J. W. Low, Bristol; Dr. A. C. M'Candlish, Sorbie; Mr. W. C. Miller, Edinburgh; Dr. J. M. W. Morison, Edinburgh; Mr. James Morton, Edinburgh; Professor Wm. Oliver, Edinburgh; Principal G. F. O'Riordan, London; Mr. A. W. Ritchie, Edinburgh; Dr. David Russell, Leven; Dr. F. W. Sansome, London; Mr. E. C. Shankland, London; Dr. R. H. Slater, Edinburgh; Mr. J. W. Struthers, Edinburgh; Professor C. W. Stump, Sydney; Dr. J. D. Sutherland, Edinburgh; Dr. C. I. B. Voge, Edinburgh, and Dr. A. C. White, Beckenham.

Sir Thomas H. Holland, vice-chancellor of the University of Edinburgh, has been awarded the Gold Medal of the Institution of Mining and Metallurgy "in recognition of his eminent services to geological science and to the mineral industries during his tenure of high public appointments—notably those of director of the Geological Survey of India and of rector of the Imperial College of Science and Technology—and of his researches and publications upon the mineral resources of the British Empire and their relationship to national and international problems."

Dr. William J. Robbins, professor of botany in the University of Missouri, who has been on leave of absence working for the Rockefeller Foundation, Paris, has been appointed dean of the graduate faculty to succeed Dr. Walter Miller.

Dr. F. L. Stevens, professor of plant pathology of the University of Illinois, has accepted the first year incumbency of the newly established Baker professorship in the College of Agriculture, University of the Philippines. He will leave the University of Illinois on May 26, going directly to Manila. After the close of his work there, he plans to collect in the neighborhood of the Malay Archipelago and of the South Seas, especially in Siam, Sumatra, Java, Bali, Rarotonga and Tahiti, returning to the University of Illinois in September, 1931.

Dr. J. W. Shipley, associate professor of chemistry in the University of Manitoba, has been appointed professor of chemistry and head of the department in the University of Alberta. The appointment followed the retirement, due to illness, of Dr. A. L. F. Lehmann, who has been in charge of the department since the organization of the university in 1907.

Dr. Willard Wylie Spencer, a graduate of Yale University, has been appointed head of the department of philosophy and logic of Miami University. Dr. Spencer is to fill the position left vacant by the resignation of Dr. Daniel Robinson last year and at present held by Dr. E. E. Powell as acting head of the department.

Mr. J. B. S. Haldane has been elected Fullerian professor of physiology at the Royal Institution, London, in succession to Mr. Julian S. Huxley.

Dr. M. A. Raines has resigned his position with Carl Zeiss, Inc., New York City, to accept appointment as associate professor of botany at Howard University, Washington, D. C.

The resignation is announced of Dr. Roger Griswold Perkins, professor of bacteriology and preventive medicine and head of the department of bacteriology and hygiene of the School of Medicine of Western Reserve University. Dr. Perkins desires to be liberated from university duties so that he may have more time for special studies. He will live at Wakefield, Rhode Island.

Professor C. W. Woodworth has leave of absence from the University of California in order to carry on work for the California Spray-Chemical Corporation.

L. W. Stephenson has resumed his work as chief of the section of coastal plain investigations in the U. S. Geological Survey after a four-month furlough for field work in Venezuela.

An expedition led by Dr. Robert F. Griggs will be sent to Alaska by the National Geographic Society during the coming summer to study the changes caused by volcanic eruptions. The party will work over the territory around Katmai Volcano and the Valley of Ten Thousand Smokes, which Dr. Griggs discovered while leading the society's expedition of 1916.

A party of scientific men and sportsmen has left New York City for Miami to join the new *Nourmahal*, Mr. Vincent Astor's 2,900-ton motor yacht, bound for Indefatigable Island, one of the least known of the Galapagos group. They intend to cut their way to the interior of the island, to which no exploring expeditions have penetrated, and expect to find new species of animal and plant life. Accompanying Mr. Astor will be Dr. Eugene H. Pool, of the New York Hospital; Clarence L. Hay, of the American Museum of Natural History; Kermit Roosevelt, C. Suydam Cutting, Robert D. Huntington, Dr. James P. Chapin, ornithologist, of the American Museum of Natural History; Dr. Henry K. Svenson, of the Brooklyn Botanical Garden; Elwin R. Sanborn, photographer, of the New York Zoological Society; Wilfred S. Bronson, artist, and Dr. Charles H. Townsend, director of the New York Aquarium, who will be scientific director of the expedition. The trip originally was planned as a pleasure cruise. Then, interested in the peculiar natural characteristics of the Galapagos Islands, Mr. Astor invited Dr. Townsend to recruit a group of scientific men for the expedition.

Dr. William J. Mayo, of the Mayo Foundation, will deliver the first Stuart McGuire Lecture at the Medical College of Virginia, Richmond, on May 12. This lectureship has been established in recognition of Dr. Stuart McGuire's presidency of the college, from which he retired in 1925. The general public as well as the profession will be invited to attend.

Colonel Bailey K. Ashford, of the University of Porto Rico, who has been chosen by the Association of Military Surgeons of the United States as the lecturer of the Kober Foundation for 1930, delivered a lecture on "Significance of Mycology in Tropical Medicine" on March 28 in Washington.

Professor L. Charles Raiford, professor of organic chemistry, Iowa State University, has been appointed visiting professor for the forthcoming summer session of Western Reserve University. Professor Raiford will offer two courses of lectures: the one on "Organic Nitrogen Derivatives," the other one on "Type Reactions in Organic Chemistry."

Dr. A. B. Stout, director of laboratories, New York Botanic Garden, lectured on March 14 at the University of Pennsylvania on "Sterilities in Plants." On March 15 he addressed the Botanical Society of Pennsylvania on the subject of "Day Lilies."

Dr. Charles R. Stockard, professor of anatomy at Cornell University Medical School, New York City, will deliver the Lane Medical Lectures for the year 1930 at the Stanford University Medical School, San Francisco, from May 5 to 9. The subjects of the separate lectures are: "Medical and Biological Aspects of Constitution"; "Germinal Constitution"; "Developmental Constitution"; "The Interplay of Inheritance and Environment in Constitution," and "Postnatal Reactions and Periodic Changes in Constitution." Dr. Stockard will also give a lecture at Stanford University on May 7 on "Structural Types in Animals and Men."

Professor Caswell Grave, head of the department of zoology at Washington University, St. Louis, gave on March 14 and 15 the following lectures at Oberlin College: "Structural Mechanisms of Ascidian Larvae which may be Involved in the Control of Metamorphic Change" and "Acceleration of Processes Underlying Metamorphosis of Ascidian Larvae."

Dr. Frank B. Jewett, vice-president of the American Telephone and Telegraph Company, gave the third Aldred Lecture in the present series at the Massachusetts Institute of Technology on February 14. He spoke on "What Industry Expects of the Graduate." The fourth lecture was given on March 14 by Major W. C. Gotshall, of New York City, on "Reflections of an Engineering Experience."

Dr. Karl Meyer, director of the Hooper Foundation for Medical Research of the University of California, will give a series of lectures at the University of Washington next July, as one of a group of medical men contributing to a short course for practicing physicians of the State of Washington.

The Honor Society of Gamma Sigma Delta and the seminars for agronomy and for botany at the Kansas State Agricultural College were addressed by Dr. Edgar T. Wherry on March 11, 12 and 13.

Lectures under the auspices of local chapters of Delta Omega, the honorary public health society, were given in March at the Massachusetts Institute of Technology and the Yale School of Medicine. At the third annual Delta Omega lecture at the Massachusetts Institute on March 4, Dr. C. C. Young, of the Michigan State Department of Health, national president of the society, spoke on "The Trend in the Development of Public Health Laboratories." The speaker at the second annual Delta Omega lecture at the Yale School of Medicine on March 14 was Dr. George H. Bigelow, State Commissioner of Public Health of Massachusetts, who discussed the official program for cancer control in his state.

Dr. A. Landé, of the University of Tübingen, now visiting professor of physics at the Ohio State University, gave a series of lectures on "Wave Mechanics" at the University of Kentucky on February 27 and 28.

Professor Jules Duesberg, professor of anatomy and rector of the University of Liége, has accepted appointment as visiting professor from Belgium to the United States under the auspices of the C. R. B. Educational Foundation, Inc., 42 Broadway, New York. Professor Duesberg will lecture in English on biological subjects during January, February and March, 1931. During the war Professor Duesberg was connected with the Johns Hopkins Medical School.

Professor E. W. Hey Groves, of the University of Bristol, delivered the Harveian Lecture before the Harveian Society of London on March 13. His lecture was entitled "Should Medicine be a Mendicant?"

Professor G. Elliot Smith gave a lecture on "The Human Brain" at the Royal Society of Arts, London, on March 12.

At the fourteenth annual meeting of the Pacific Division of the American Association for the Advancement of Science, to be held at Eugene, Oregon, from June 18 to 21, the Thursday evening address will be presented by Professor A. E. Douglass, of the University of Arizona. Dr. Douglass will discuss tree rings in relation to the history and ethnology of the southwest. His lecture will be illustrated by slides and motion pictures.

The Pacific Section of the Botanical Society of America will hold its regular annual meeting in conjunction with the Pacific Division at the University of Oregon. Any botanist not a member of this division but who can attend these meetings is cordially invited to do so. Those desiring to give papers should notify the secretary of the botanical section, E. T. Bartholomew, Citrus Experiment Station, Riverside, California, not later than May 1, giving the title of the paper, the length of presentation time, and stating whether the use of a lantern is desired.

The Ohio Academy of Science will hold its fortieth annual meeting at Ohio State University on Friday and Saturday, April 18 and 19, under the presidency of Dr. F. C. Waite, of Western Reserve University. In general the program will follow that of other years, namely, a business session followed by a general scientific session in the forenoons, and sectional meetings in the afternoons, with a banquet followed by the presidential address on Friday evening. One interesting feature will be an illustrated lecture on "The Mound Builders—the First Ohioans," by Director H. C. Shetrone, followed by a personally conducted tour of the museum.

The first meeting of the American Association of Physical Anthropologists will be held from April 17 to 19, at the University of Virginia, Charlottesville, coincidentally with the meeting held by the American Association of Anatomists. A program will be devoted to the subjects of mutual interest to the two societies. Detailed information concerning the objects and scope of the organization may be obtained from the chairman, Dr. Aleš Hrdlička, of the U. S. National Museum.

The eighteenth annual meeting of the Eugenics Research Association will be held on Saturday morning (10:30), May 17, in New York City at the McAlpin Hotel. The day will be spent in eugenical programs, the morning being devoted to the Eugenics Research Association, the afternoon to the American Eugenics Society and the evening to the eugenics dinner, which will be the occasion for two short addresses on eugenical problems.

The one hundred and sixty-third regular meeting of the American Physical Society will be held in Washington, on April 25 and 26. The Friday sessions will be held at the Bureau of Standards and the Saturday sessions at the National Academy Building. Those working on problems in "applied" physics are especially invited to report their researches at this meeting. It is planned to have at least one of the regular sessions on Friday devoted entirely to such papers.

The date of the forthcoming congress of the International Society for Microbiology has been altered by the Central Committee in Paris to July 20 to 25.

The fortieth anniversary of the Ecole de Psychologie of Paris, founded by Dr. Bérillon, was recently celebrated at a meeting attended by Professors Richet, Pierre Janet, Roux, Menetrier and Marcel Labbé.

The will of the late William H. Nichols, chairman of the Board of the Allied Chemical and Dye Corporation, bequeaths $1,000,000 to public purposes. Half of the residuary estate is left to New York University for the maintenance of the Nichols Chemical Laboratory, which Mr. Nichols gave to the institution in 1927. He served as acting chancellor of the university last spring and fall during the illness of Chancellor Brown. It is requested that the bequest be used to keep the laboratory "at all times in good order and repair and well equipped." The largest institutional legacy is $250,000 to the Polytechnic Institute of Brooklyn. Mr. Nichols attended that school for three years in his youth and was vice-chairman of its board. The American Chemical Society and the American Society for the Control of Cancer each receive $50,000.

Princeton University will receive a trust fund of $1,165,212, representing one half of the residuary estate of William Burhans Isham. The university will also receive a remainder interest amounting to $95,139 in the residence of the testator and a chest of silver valued at $2,500.

Bequests received by De Pauw University during the past two weeks include a legacy of $200,000 for a chair of philosophy from James Nelson, of Indianapolis; the bulk of the estate of John H. Harrison, of Danville, Illinois, valued at between one and two million dollars, and approximately $150,000 from the estate of Marion B. Stultz, late trustee of the university, who named De Pauw residuary legatee in his will after giving his wife a life interest in his estate.

The American Museum of Natural History receives $557,361 under the will of Frederick G. Voss. The bequest is to be used in the further development of research in anthropology and archeology.

The University of London has received a bequest by the late Lady Durning-Lawrence of £10,000, for the equipment of the physical and electrical chemistry laboratory at University College.

Former Senator George Wharton Pepper will head a committee of the Benjamin Franklin Memorial, Incorporated, in a campaign to raise a fund of $5,000,000 for the erection of a science museum and memorial to Franklin on the Parkway, Philadelphia.

The House has passed a bill (H. J. Res. 210) authorizing an appropriation of $15,000 for the expenses of official delegates of the United States to the World's Fourth Poultry Congress, to be held in England from July 22 to 30. Funds had previously been appropriated for a United States Government exhibit. The Office of Motion Pictures of the Extension Service of the U. S. Department of Agriculture is making a series of eight poultry motion-picture films for the exposition. Two of the eight have been finished though not yet released—The Turkey Business and Breeding for More and Bigger Eggs; three are in production—The Egg Marketing of the United States, The Poultry Marketing Industry of the

United States and Cooperative Marketing—Eggs and Poultry, and films on which scenario work has been done, but on which production has not started, are Brooding and Rearing Chicks, Eradication of Poultry Parasites and Rearing Chicks in Confinement.

IT is stated in *Nature* that the International Union for Pure and Applied Chemistry has now been reconstituted and brings in the German chemical societies under mutually acceptable conditions. Before this could be accomplished, it was necessary for three of the leading German chemical societies to form a joint committee for international occasions. This Verband Deutscher Chemischer Vereine has been able to negotiate with the Union Internationale de la Chimie Pure et Appliquée. The new constitution and statutes are given in an article by Professor Haber, president of the Verband D. C. V. in the *Zeitschrift für Angewandte Chemie.* The new title is to be Union Internationale de Chimie, omitting the words pure and applied. The new statutes were agreed upon at Scheveningen in June, 1929. German adhesion to the reconstituted union is subject to the understanding that in its new constitution the International Research Council will not hinder the autonomy and free development of the union.

THE London *Times* reports that the British Association for the Advancement of Science has been summoned at Bromley (Kent) for the non-payment of rates on Downe House, Charles Darwin's old home. Mr. Weller, who appeared for the Bromley Rural District Council, said that points of law were involved and counsel had been instructed on both sides. The case was adjourned. Downe House was presented to the British Association by Mr. Buckston Browne as a national memorial to the great naturalist, and was opened last June by Sir Arthur Keith.

ARRANGEMENTS are being considered by which graduate students in meteorology at the Massachusetts Institute of Technology may be sent to the University of California Scripps Institution of Oceanography at La Jolla, California, to acquire additional knowledge of the subject.

THE Frederick H. Rawson-Field Museum Ethnological Expedition to West Africa has completed its work in Angola (Portuguese West Africa) and Nigeria (British West Africa), and is returning with extensive collections. The expedition, under the leadership of Assistant Curator W. D. Hambly, has collected large amounts both of exhibition and study material representing many tribes of which little scientific knowledge had previously been available. In addition to collecting artifacts, the expedition made still and motion pictures of natives engaged in many occupations, took dictaphone records of their languages and collected various other data for scientific reports. The Chancellor-Stuart-Field Museum Expedition to the South Pacific has also returned with important collections for the department of zoology. The expedition worked in Australia and New Zealand as well as in the Dutch East Indies. Philip M. Chancellor, of Santa Barbara, California, was both sponsor and leader of the expedition. Associated with him as coleader was Norton Stuart, naturalist, also of Santa Barbara.

THE British government has decided to more than double the allocation of funds for forestry extensions for the second period of ten years under the national afforestation scheme. For the first ten years a sum of £3,500,000 was allotted, with the help of which an area of 164,000 acres will have been planted by the end of this year. In addition to this, some 70,000 acres have been planted by private landowners and local authorities. The planting of this area has meant the employment of about 3,500 men in winter and 2,500 in summer. Nearly 700 small holdings have been established providing all-the-year-round work for that number of families. These family holdings also mean the growing up of a class of skilled forest workers. Forest work for 150 days in the year is guaranteed, while for the remainder the forester is allowed to work on his own 10-acre holding.

THE Radium Commission, London, announces, according to the *Journal* of the American Medical Association, that the 4-gm "bomb" has been received from Belgium and, after being measured and tested in the National Physical Laboratory, it was handed over to the Westminster Hospital, where arrangements for its installation and manipulation and the treatment of patients had already been made. If at the end of three months the National Radium Trust decides to purchase the radium composing the bomb, it will be entrusted to the hospital for a further period of three years at a rental of $2,000 a year, and the hospital will maintain a continuous day and night service with the bomb, in the pursuit of objectives prescribed by the commission. The commission has decided to recognize as national radium centers only such places as possess medical schools with complete clinical courses and facilities for giving instruction in radium therapy. The commission believes that the need for trained workers is even more urgent than the supply of radium itself. It will initiate all negotiations for the constitution and equipment of national radium centers through the medical faculties of the local universities concerned. When the respective claims and requirements of the various radium centers have been considered and assessed by the commission, the allocation of national supplies of radium will be commenced. Orders have already been placed by the trust for 10 gm exclusive of the 4-gm bomb, and it is anticipated that the whole of this should be available before the autumn of 1930. It has been decided to install a radon plant at the National Physical Laboratory for the purpose of supplying (under proper safeguards) radon to hospitals or other institutions which otherwise could receive no direct assistance from the commission for radium therapy.

DISCUSSION

ENVELOPING MEMBRANES OF ECHINODERM OVA

The fertilization membrane of Echinoderm ova has been made a subject of discussion in two recent communications to SCIENCE, one by A. R. Moore, "The Function of the Fertilization Membrane in the Development of the Larva of the Sea Urchin,"[1] and the other by E. E. Just, "The 'Fertilization' Membrane of Echinid Ova."[2]

The former is a statement of certain facts from which a rather sweeping conclusion is drawn, while the second cites observations on one kind of ovum to refute the conclusion of the former dealing with another kind of ovum.

Moore, using the ova of *Strongylocentrotus purpuratus,* found that eggs treated with urea and subsequently fertilized form no fertilization membranes, and when segmentation sets in the blastomeres fall apart. He concluded that membrane formation (by which he evidently means the fertilization membrane) is of fundamental importance to the development of organisms consisting of closely associated groups of cells. He should have restricted this conclusion to urea-treated Strongylocentrotus eggs.

It is to be deplored that Just makes no mention of the species on which he bases his conclusions. Presumably he has reference to the Woods Hole Echinids *Arbacia punctulata* and *Echinarachnius parma.* In addition to using data of his own on the removal of the fertilization membrane Just gives credit, albeit dubiously, to the micro-dissection method by means of which the vitelline membrane has been removed from the uninseminated eggs of both these species.[3] Such eggs, when subsequently fertilized, segment and develop into normal embryos with no fertilization membranes.

Hence, both investigators are correct if only they had restricted their divergent conclusions to the particular species with which they worked; namely, when the Strongylocentrotus ovum is divested of its fertilization membrane by means of urea its blastomeres do not hold together to develop into an embryo, while the Arbacia and Echinarachnius eggs, on the other hand, are fully capable of normal development without fertilization membranes.

I have not worked with the Strongylocentrotus egg, but from Moore's observation I judge that it closely resembles the Woods Hole Asterias egg in regard to the cohesive properties of the blastomeres. In the Asterias egg the early blastomeres are loosely distributed within the fertilization membrane and only by careful observation can one detect a delicate, secondary membrane, investing the outer borders of the blastomeres and extending between them. This membrane, which develops on the surface of the egg several minutes after the fertilization membrane is lifted off, is too weak to hold the blastomeres together so that they would fall apart if it were not for the externally investing fertilization membrane. Moreover, this secondary membrane is formed only when a bivalent electrolyte (Ca or Mg) is present in the surrounding medium.

In the Arbacia and Echinarachnius egg a similar secondary membrane is formed, the so-called hyaline plasma layer, and it is strong enough to hold the blastomeres firmly together without the aid of the fertilization mebrane. This secondary membrane can be torn with micro-needles, in which case the blastomeres fall apart.[4] This and the fertilization membrane constitute the anatomical structures (quite apart from the true plasma membrane of each individual cell) which Moore rightly concludes are necessary to permit normal development by keeping the cells closely associated.

ROBERT CHAMBERS

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[1] 70: 360, October 11, 1929.

[2] 71: 243, February 28, 1930.

[3] Chambers, *Biol. Bul.*, 41: 318, 1921.

[4] *Anat. Rec.*, 25: 121, 1923.

THE ELECTRON AND RADIATION

The electron has been shown[1] in several ways by me to possess certain fundamental properties. It is of course desirable that this result should be obtained in as many ways as possible, and one more will therefore be given here.

Consider a closed chamber with perfectly reflecting walls whose total mass is infinitely large so that they may withstand any pressure. Suppose that the chamber contains a single free electron, and a particle of matter to insure that the chamber contains black body radiation. Further suppose that an alternating electric field is applied to the chamber so that the electron moves to and fro, but without touching the walls. If the electron is perfectly reflecting it will perform work upon the radiation, and the temperature will accordingly continually increase till the radiant energy per cc is infinite. But such a concentration of energy, we may take it, is impossible. The electron can not therefore be perfectly reflecting, or it absorbs besides reflects radiant energy. Now a continual increase in its internal energy through absorption of radiation on account of its motion is not permissible, since in that case its internal energy would ultimately become infinitely large, and hence it is periodically converted into some other form. This can not be radiation produced by acceleration, since the energy required for this is derived from the kinetic energy of the electron, or the energy of the applied field. The internal energy must therefore be converted directly into radiation, and hence the electron may radiate in two entirely different ways.

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[1] *Phil. Mag.*, 7: 493, 1929; SCIENCE, 70 (1820): 479, 1929.

But even under these circumstances the applied field will perform work upon the electron, for the energy converted into radiation through acceleration may be varied through the applied field, and this work ultimately appears as radiation. Thus the density of the radiation may be made infinitely large, which we have seen is impossible. It follows, therefore, that ultimately the applied field should have no effect on the electron, or that its field decreases till zero. Since the temperature under these conditions will be very large, causing a large absorption of radiant energy by the electron, its average amount of internal energy will in consequence be very large. Thus in a general way the external field of an electron decreases with increase of its internal energy.

We might also in the beginning have supposed that the force on the electron decreases with increase of density of radiation. Since the density would nevertheless become infinite, we must suppose that the force becomes zero for a finite density. This is possible only if the electron undergoes a change, which naturally involves a change in internal energy, and so on.

R. D. KLEEMAN

SCHENECTADY, NEW YORK

NOTE ON HAEMOGLOBIN

DURING the course of a spectrographic examination of horse and fowl haemoglobin we have noted that the absorption band, whose peak appears at AU4100 for oxyhaemoglobin and AU4300 for haemoglobin in solutions of the above compounds, does not appear when washed corpuscle suspensions containing haemoglobin and oxyhaemoglobin in similar concentrations are examined. Furthermore the absorption which begins at AU2500 in solutions of horse haemoglobin also is absent when haemoglobin or oxyhaemoglobin is observed in washed cell suspensions. The specific bands in the visible regions of solutions of the above pigments are observed in the washed cell suspensions in their usual location.

Apparently there is, in the case of haemoglobin in the cell, a possibility that it is in combination with some constituent of the corpuscle. This problem is one of several concerning the blood pigment for which we are attempting to find a solution.

A. BRUCE MACALLUM
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A FOSSIL MAMMAL WITH UNBORN TWINS

THE South Dakota State School of Mines has recently mounted and placed on exhibition in its geological museum a most unusual fossil vertebrate specimen from the Oligocene of South Dakota. This is a superbly preserved skeleton of a mother *Oreodon* (*Merycoidodon*) *culbertsoni* with unborn twins. It is the only known occurrence of a fossil mammal accompanied by unborn young.

The specimen was found by the School of Mines collecting party of 1928, Mr. James Bump, Mr. Robert Hernon and Mr. Harold Martin, in the Lower Oreodon beds of Cain Creek, about two miles north of Imlay in the heart of the Big Badlands. Only a small portion of the skull of the mother was exposed to the weather. Excavation disclosed the complete skeleton except that the ribs on the right side were mostly missing. Upon turning over the block in the field for final shellacking and other protection, the skulls of two unborn individuals, lying within the pelvic region, were discovered. A photograph of the rough block made in the preparing room before work was begun upon it shows in good way much of the skeleton of the mother and the positions occupied by the twins.

The mother skeleton, the right side showing, is mounted in relief on a nicely tooled slab. The skeletons of the twins are only partially preserved. Some of this loss is due doubtless to the cartilaginous, nonpetrifying nature of the material. The better portions are the skulls and some of the larger leg bones. The skull of one is well preserved and nearly perfect. The other may be easily discerned but is much crushed and the parts displaced. Both skulls show well-developed teeth. The cranial bones are very thin and delicate and much care was necessary to prevent injury to them. In the mounting of the specimen it was thought advisable not to attempt extracting the fetal forms completely from their matrix. They were mounted with the mother skeleton pretty much as found without attempting, however, to place them in theoretically exact position.

The School of Mines has had a collecting party in the White River Badlands during the last six field seasons. The results of this work have been most gratifying in that the institution now has a large collection, representative of this important life period, much of which has been prepared, mounted and placed on exhibition. The collection contains an especially good representation from the Protoceras channel beds.

Cleophas C. O'Harra

South Dakota School of Mines

BABYLONIAN MATHEMATICS

In my address on "Mathematics before the Greeks" recently published in Science[1] I quoted a statement from Smith's "History of Mathematics"[2] to the effect that "in a tablet from Sennacherib's palace (about 700 B. C.), now in the British Museum, a circle is divided into 480 equal parts." Professor Smith does not give any authority for this statement but informed me privately that he probably learned of the fact during a visit to the museum. On appealing to Mr. C. J. Gadd, of the Department of Egyptian and Assyrian Antiquities, I learned recently that the tablet in question was almost certainly the one numbered K90, discussed by Hincks, and Bosanquet and Sayce, and referred to by more than one historian of mathematics. Mr. Gadd drew my attention also to an important discussion of this tablet by F. X. Kugler, in his "Sternkunde und Sterndienst in Babel," 2. Buch, 1. Teil, 1909, pp. 45–50. The views of Hincks rather than those of Bosanquet and Sayce are here upheld. In this connection Kugler refers to an article by Schiaparelli in *Scientia,* vol. 3, 1908; this is also in Schiaparelli "Scritti sulla Storia della Astronomia Antica," vol. 1, 1925, see especially page 23.

In the paragraph just before the last of my address I summarized, in about a dozen lines, some of the astronomical knowledge of the Babylonians. My friend Professor Cajori inquired if I intentionally omitted any reference to the Babylonian discovery of the precession of the equinoxes. This was a discovery of about 350 B. C. and hence should hardly be included in a survey of "Mathematics before the Greeks." It is, of course, a matter of great interest, and in my recently published "Bibliography of Egyptian and Babylonian Mathematics" I refer to Schnabel's important paper on the subject (1927) as well as to Professor Cajori's review of it in Science.[3] Schnabel's article seems to have been developed from a part of Kugler's work, mentioned above, published in 1924.

R. C. Archibald

Brown University

USEFUL GREAT TOES

A number of years ago, in the Louvre Galleries, in Paris, an artist who was born without any arms was a familiar sight. He was painting copies in oil of the principal masterpieces in the gallery and made thereby a comfortable living. That fact shows that the copies were of good quality.

But every one would ask at once how *could* he copy these paintings in oil without any hands? It was done entirely by means of the, to us, useless great toes and their next neighbor, the second toes. He held the brushes between these toes.

One morning when I happened to be in the gallery at the usual hour for the *déjeuner à la fourchette,* I saw him just finishing his meal. He seized a pint bottle with the left toes and grasping the cork with the corresponding toes on the right foot uncorked the bottle, lifted it to his mouth and after drinking all that he wished replaced the cork with the right toes and then with the sole of the right foot gave it a smart tap to replace it firmly.

W. W. Keen

SCIENTIFIC BOOKS

Revision of the American Chipmunks. By Arthur H. Howell. North American Fauna, No. 52. U. S. Department of Agriculture, Bureau of Biological Survey. November, 1929. 157 pp.

The appearance of the "Revision of the American Chipmunks," long known to be in course of preparation, is a zoological event of importance. These animals, so attractive to every lover of nature, are of more than ordinary interest to students of evolution on account of the great number of local forms. Modern methods have made it possible to deal with the subject very thoroughly, no less than 14,554 specimens having been examined. Sixty-five species and subspecies are recognized in North America, including Mexico. There are chipmunks also in northern and northeastern Asia, and it is found that the whole series falls into three main groups, the Asiatic *Eutamias,* the western American *Neotamias* (defined and named in the work reviewed) and the eastern American *Tamias*. The two latter overlap in the region around Lake Superior. Singularly enough, the Siberian *Eutamias* resembles in a number of characters the eastern American *Tamias;* so much so that Pallas in 1778 thought that the Siberian and American animals were mere forms of a single species. However, the dentition of *Tamias* is the most modified, the upper premolars being reduced to two, instead of four as in the other two groups. Howell treats *Tamias* and *Eutamias* as genera (following the current usage of modern authors), and *Neotamias* as a subgenus of the latter. The probable inference would seem to be that *Eutamias* represents most nearly the stem-form, having at an early date sent to America the ancestors of *Tamias,* and more recently those of *Eutamias,* which, being a livelier and more variable animal, supplanted *Tamias* in the west. This is at present mere guessing, but it may be that fossil *Tamias* will be found in the west some day.[1] The characters and distribution considered, there is perhaps some basis for considering *Neotamias* a genus (type *Neotamias merriami* Allen).

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[1] Science, 71: 109, January 31, 1930.

[2] Vol. 2, p. 230.

[3] Science, 65: 184, February 18, 1927.

When we come to the species and subspecies, there is very much of interest. In *Tamias,* Howell recognizes one species with five subspecies. In *Eutamias* (*Neotamias*) he has sixteen species and sixty forms in all, including subspecies. The subspecies are found to intergrade and it is to be determined whether these intergradations are directly related to the environment or whether they are due to crossing between races which meet each other in some part of their range. That the environment affects the characters is shown by the repeated development of dark or richly colored animals in humid districts, and pallid ones in drier districts. An interesting case is that of *Eutamias minimus caryi,* which occurs only in the dry lowlands of the San Luis Valley, Colorado, while the mountains northward, eastward and westward are occupied by the larger and darker *E. minimus operarius.* At 8,200 feet specimens were found connecting these races. Reviewing the numerous cases of intergradation recorded, one is struck by the various combinations of characters, exactly as in the case of hybrids. It seems certain that we have to do with hybridization in the majority of instances, and this in itself need not necessarily indicate subspecific rather than specific rank. But in any case, the "subspecies" are closely allied, and their precise rank is a matter of minor importance.

Although the work has been so thoroughly done, the subject is by no means exhausted. There are still many localities where collecting is desirable, and additional forms may yet be found on isolated mountain ranges. Hybridization in captivity should be attempted. Many anatomical features have yet to be compared in the different forms, for example, the auditory ossicles, the alimentary canal, the musculature. Although it is outside the scope of Howell's revision, one would like to see a chapter on the internal and external parasites and the predatory enemies. The food habits are treated interestingly and quite fully by Howell, who also discusses nesting habits and hibernation. We are not quite sure that the chipmunks would approve of a picture of a weasel on the cover of the work.

The bulletin may be purchased for a trifle, but we wish the government would use better paper and type for such important papers of permanent value.

T. D. A. COCKERELL

BOULDER, COLORADO,
DECEMBER 21, 1929

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE SPOT-PLATE TEST FOR NITRATE NITROGEN IN SOIL AND OTHER EXTRACTS

THE diphenylamin test, usually conducted as a "ring" test, gives purely qualitative results. The blue color that appears in the ring test is lost when the sulphuric acid reagent and the liquid to be tested are mixed together, since it occurs only in sulphuric acid concentrations of 70 to 90 per cent. There is a definite need for a quick and simple nitrate test for soil extracts, drainage waters, plant juices or plant extracts that gives approximate quantitative results. For instance, in the field of soil science, it is desirable to study the nitrate nitrogen content of the soil from day to day or from week to week during the growing season. Exact quantitative measurement by the phenyldisulphonic acid or Devarda's alloy methods is laborious and the delay involves a loss of valuable time before necessary corrective steps can be made, as is the case when the soil drops so low in nitrate nitrogen content as to fail to nourish the plant properly.

The author has applied the principle of the very sensitive diphenylamin color reaction to a spot-plate technique. The reagent is a freshly prepared solution of 0.05 gm of diphenylamin in 25 cc of concentrated C. P. sulphuric acid. This is conveniently used from a glass-stoppered bottle of clear glass. The writer has attempted to use amber glass containers, but for some reason the reagent is contaminated by contact with the ground glass stopper of the amber-colored dropping bottle. Hence it seems preferable to make up at once only a sufficient amount of the reagent for use within two or three days' time, rather than attempt to store it in only partially lightproof bottles which might produce contamination.

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[1] An extinct species, *Tamias nasutus* Brown, has been found in the Pleistocene of Arkansas.

A common artist's slab with circular depressions one inch in diameter and one fourth inch deep is the most convenient vessel for conducting the test. One drop of the solution to be tested is transferred to one of the depressions by means of an eye-dropper pipette. Four drops of the reagent are added, and the liquid stirred with a two-inch glass rod until a full color develops, which requires about two minutes. The intensity of the blue color is an approximate quantitative measurement of the nitrate nitrogen content, within the limits of from 1 to 25 p.p.m. of nitrates expressed as nitrogen. Above about 25 p.p.m. the blue color is so intense that little variation can be observed. In such cases the liquid to be tested must be diluted five, ten or more times, so that one drop of the diluted liquid will fall within the above limits. In such cases the final test is on the basis of one drop of the diluted liquid to four drops of the reagent, with calculation of results on the basis of the dilution.

A color chart of satisfactory accuracy can be made up with water colors. The color blocks in Ridgway's "Color Standards and Nomenclature," that most closely approximate the chart used by the author, is as follows:

Nitrate nitrogen concentration p.p.m.	Color name	Book Plate 1 No.
1	Pale forget-me-not blue	XXII
2	Pale violet blue	IX
3	Light violet blue	IX
5	Dull violaceous blue	XXII
7	Phenyl blue	IX
10	Helvetia blue	IX
15	Hays blue	IX
20	Cyanine blue	IX

The purity of the reagent can be ascertained by a blank test with one drop of distilled water. If no permanent blue color appears, the reagent is satisfactory for use on that day.

The results of the author and one of his associates in the determination of nitrate nitrogen in the leachate from 136 greenhouse lysimeters containing seventeen different soils, some pots of which had been previously treated with urea, both with and without lime, are of interest as an evidence of the accuracy of the spot-plate test. One person made the nitrate-nitrogen determination by the accurate phenyldisulphonic acid method, while the other conducted the spot-plate tests. Results were compared subsequent to recording the results. Space does not permit publication of the individual results, but the following table summarizes the data in comparative form:

No. of samples in group	Exact method NO_3-N p.p.m.	Spot-plate tests NO_3 N p.p.m. range	No. of samples within group limits
23	0– 20	0– 25	20
18	21– 50	20– 75	14
27	51– 100	30– 150	19
28	101– 200	75– 300	20
19	201– 350	200– 500	16
15	351– 500	300– 600	11
6	501–1000	500–1000	5

Several applications of this test suggest themselves. For soil tests, the author employs the special porcelain block used in connection with the LaMotte-Morgan Soil Testing Set to obtain the soil extract. Where the soil compartment of this block is filled to its normal capacity and distilled water permitted to soak through the soil in amount sufficient to fill the test cup, one drop when transferred to the artist's slab and tested for nitrates as described above gives results in p.p.m. of soil extract which can be interpreted as pounds of nitrate nitrogen per acre to plow depth. Dilutions are employed when necessary.

Another very important use of the test is the determination of nitrates in expressed plant juices and extracts. A suggested method is the maceration of small portions of fresh plant tissue in one compartment of the artist's slab, the addition of a drop or two of water if necessary in order to obtain a drop of expressed juice for transfer and the subsequent test. Good results have been obtained with green tissue in studies of the nitrate content of newly developed nodal portions of herbaceous pasture and forest plants.

M. FRANCIS MORGAN

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THE CAPNOMETER, AN INSTRUMENT FOR THE MEASUREMENT OF AIR POLLUTION

FROM the beginning of Mellon Institute's Air Pollution Investigation, a year ago,[1] it was recognized that the photoelectric cell would play an important part in the determination of the amount of atmospheric contamination and its distribution outward and upward from sources. Sampling devices ordinarily enable one to estimate the content of solids in a small volume of air at a given time and place, or the total amount at a given place over a period of time. It was desirable, however, for us to have a continuous record, not only of the amount of pollution, but also of the effects of atmospheric conditions upon the distribution of solids after their emission from stacks or other sources.

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[1] L. W. Bass, SCIENCE, 70: 186, August 23, 1929.

With the helpful cooperation of members of the staff of the Westinghouse research laboratories, experiments were made first for work at short range, and in consequence a combination has been developed that may be used at night or in the daytime. It consists essentially of a source light with a modulator, a receiver and amplifier, tuned, and an indicator or recorder, calibrated. It differs from "smoke indicators" in that it need not be attached to a smokepipe or stack and also in that it operates independently of any influence from daylight or artificial light other than that from the controlled source.

At the suggestion of W. A. Hamor, assistant director, Mellon Institute, the apparatus has been named the *capnometer* (> Greek *kapnos*, smoke, and *metron*, measure), for its purpose is to measure smoke—*capnometry*.

From the results of the work done in the laboratory, there is every indication that the apparatus will be very helpful in the capnometric part of Mellon Institute's program and in securing data concerning the influence of furnace and firing conditions, precipitation, wind velocities, etc., upon the density due to pollution of the atmosphere.

H. B. MELLER
Head, Air Pollution Investigation
MELLON INSTITUTE OF INDUSTRIAL RESEARCH

SPECIAL ARTICLES

A THEORY OF THE RING METHOD FOR THE DETERMINATION OF SURFACE TENSION

DURING the last few years several papers concerning various phases of the ring method for the determination of surface tension have appeared in SCIENCE. It is desirable that this discussion also appear here especially because it is closely related to one of these papers. An experimental study of the ring method by Harkins, Young and Cheng[1] has shown that this method, as usually carried out, does not give true surface tension values. The results of Harkins and his collaborators are expressed in the form of a series of empirical correction curves which involve a value of the surface tension given by an absolute method. They have demonstrated that the value of the surface tension as given by the pull on a ring and the relationship

$$W = 4\pi R \gamma \qquad (1)$$

must be modified by these correction curves if that value is to be regarded as being, in fact, that of surface tension. The purpose of this preliminary paper is to announce that a theoretical basis for this empirical correction procedure has been developed, thus making the ring method, as modified, an absolute one, since by it surface tension may be determined without reference to any other method.

The basis of our theory is Laplace's equation for stable liquid surfaces expressed in the particular form applicable to surfaces of revolution, with the capillary constant (a^2) eliminated,

$$\frac{du}{d\bar{x}} + \frac{u}{\bar{x}} = \pm 2\bar{y} \qquad (2),$$

where u is the sine of the angle made by a tangent to the surface at any point $(\bar{x}, \bar{y})$ with the $\bar{x}$-axis. The $\bar{x}$-axis in this case is chosen at the undisturbed level of the liquid, and the $\bar{y}$-axis is the axis of symmetry. In this form the equation expressed shapes of surfaces, not their actual dimensions. If the latter are to be expressed, a^2 or its equivalent $\frac{2\gamma}{gd}$ must be known, where γ and d are respectively the surface tension and density of a particular liquid. Barred symbols as used by us are dimensionless, thus $\bar{x} = x/a$ and $\bar{V} = V/a^3$. But we shall speak of them, for convenience, as lengths and volumes. This equation formulates the shapes of all types of stable liquid surfaces of revolution. The ring method involves two of these types, the meniscus and the surface held up by a wetted disk. To get the actual shapes of these surfaces the equation must be integrated, which must be done in this case by series.

The shapes of the meniscus formed inside the ring are obtained by numerical integration in the ordinary way. But the integration for the outer slope presents a difficulty in that there is no known point at which to start. We have obviated this difficulty by an assumption which, however, introduces an error much less than any in the experimental procedure. These two integrations give a cross section of the liquid raised by the ring in any position. It takes the form of two curves tangent to a circle, one curve being the shape of the meniscus, the other being that of the outer slope, and the circle being the cross section of the wire, of radius r, of which the ring is made.

The volume below these surfaces is calculated. It is found to pass through a maximum as the distance of the ring from the x-axis increases. Our theory identifies the weight of this maximum volume below the surfaces with the maximum pull on the ring as found experimentally. Harkins, Young and Cheng plot a function of this maximum pull, R^3/V, where R is the radius of the ring and V is the volume of the liquid equivalent to the weight measured by this pull, against γ/p, a curve for each value of $\frac{R}{r}$, where γ is the surface tension of the liquid as determined by a reference method, and p is the pull on the ring divided by $4\pi R$. We show that γ/p is equal to $2\pi\overline{R}/\overline{V}$, a ratio which does not involve the determination of γ by any other method. Now the correction curves found by Harkins and his collaborators are identical with the curves calculated by us from the maximum volume below the surfaces and plotted as indicated, *i.e.*, $\overline{R}^3/\overline{V}$ by $2\pi\overline{R}/\overline{V}$ for a particular $\overline{R}/\overline{r}$. Our calculated curves are probably not as precise as the experimental ones because of the lack of sufficient calculated surfaces and the errors due to the consequent interpolations. But the excellent agreement that is obtained shows that the same values of γ, within the small error of both methods, are obtained whether the relative corrections of the Harkins procedure or the absolute corrections as calculated by us are used. Thus the ring method may now be considered an absolute one, since by it surface tension may be determined without reference to any other procedure. A detailed discussion of this theory is to be published soon.

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[1] Harkins, Young and Cheng, SCIENCE, 64: 93, 1926.

B. B. Freud
H. Z. Freud

PROLONGED EFFECT ON DIGITALIS PURPUREA OF EXPOSURE UNDER ULTRA-VIOLET-TRANSMITTING GLASS

For the past three years, a study has been made of the effect produced upon *Digitalis purpurea* L. by exposure in the greenhouse stage under an ultra-violet-transmitting glass. *D. purpurea* is well known as the common garden foxglove, and is also a very important medicinal plant. In 1927 and again in 1928, seedlings were grown about three months under an ultra-violet-transmitting glass, with controls under ordinary glass in an adjacent section of the same greenhouse. Thus it was possible to eliminate differences of temperature, moisture and other factors.

Both series were then grown in adjacent beds under open field culture conditions; and in each year, as reported[1] at the Nashville and New York meetings, the treated plants proved considerably superior to their controls in the content of the characteristic active principles.

The final report now to be given concerns the history of the 1928 plants during their second season of growth, this species being biennial. By careful mulching they were brought through the winter in good condition. Our capricious Michigan weather in 1929 made it necessary to water the plants last summer throughout a season marked by severe drought; but all were treated the same, and had attained the normal early blooming stage at the time the samples were harvested.

For many years it was held that second-year leaves were more potent than first-year herbage but eventually this idea was refuted. We now know from numerous tests that greater activity occurs during the first year of a digitalis plant's life. Therefore, it is to be noted that the actual percentages now given, obtained from second-year growth, are not as high as those previously reported from first-year leaves; but the relative values are again confirmed; the treated plants have the higher potency. Exact values are as tabulated below, all methods having meticulously followed those heretofore used.

Treated group	250 per cent. of standard
Control group	165 per cent. of standard

Increase of potency, 51.5 per cent.

It thus seems clearly established that *D. purpurea* is benefited permanently by exposure during seedling development under glass that affords an increased amount of ultra-violet radiation. Where digitalis passes its whole cycle under natural, out-of-door conditions in a mild climate, this fact may not be of great significance, but for successful culture of high-grade plants in Michigan we must depend in large measure upon indoor protection during the seedling stage. It is gratifying, therefore, to know that modern methods of glass making have increased the efficiency of greenhouse propagation.

Adelia McCrea

Research Department,
Parke, Davis and Company

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[1] A. McCrea, Science, 67, No. 1732, 1928; 69, No. 1798, 1929.

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Fowler, Sir James K. *The Sthenics.* Pp. 81. Macmillan. $1.40.

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THEORETICAL MECHANICS IN ENGINEERING SCHOOLS

By Professor WILLIAM HOVGAARD

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As indicated by the title, it is proposed to deal with theoretical mechanics chiefly from the engineer's point of view, but in modern engineering colleges it is impossible to draw a sharply defined line between the education of engineers and physicists. The modern engineers of advanced scientific standing, notably research engineers of all professions, are required to be physicists as well as engineers. Moreover, a high-grade technical school seems to afford the best environment for the education of physicists, while physics forms one of the most important disciplines in the education of engineers. We shall therefore on several occasions refer to the requirements of the physicists.

Mechanics is commonly subdivided into two parts, theoretical and applied, but it is proposed here to deal in particular with the former, which bears a close relationship to mathematics and, in its widest sense, forms the main body of what is usually called applied mathematics. Often the two parts of mechanics, the theoretical and the applied, are dealt with and taught together, but it will be here attempted to distinguish rather sharply between them, although it is not always easy to do so.

The name applied mechanics is misleading and confusing. As commonly understood this science deals only with the application of theoretical mechanics to structural and mechanical engineering, but it might with equal right be said to deal with other branches of engineering where theoretical mechanics in the modern and wider sense is applied to the same extent. We shall not, however, try to widen the meaning of the term applied mechanics beyond common usage, but rather extract that which does not belong to it, for as taught at present it comprises much of an abstract nature which properly belongs under theoretical mechanics. The name technical mechanics (technische Mechanik) would seem better than applied mechanics, being more readily distinguished from theoretical mechanics.

We divide the science of theoretical mechanics into four sections in accordance with the nature of the bodies with which it deals: (1) Mechanics of a particle and of rigid bodies; (2) mechanics of elastic bodies; (3) mechanics of fluids, and (4) mechanics of gases. In the following we shall refer to these sections by their numbers.

Under each heading we consider separately equilibrium and motion, and the latter falls into two parts according as we consider motion with or without regard to the forces which produce it. We have thus a further subdivision into three parts: (a) Statics; (b) kinematics, and (c) kinetics or dynamics.

In accordance with this definition we include under theoretical mechanics the following subjects:

Statics, kinematics and kinetics of a particle and of rigid bodies; theory of elasticity; elastostatics and elastokinetics; plasticity; hydrostatics, hydrodynamics and aerodynamics.

Vector analysis and calculus of variation in their application to mechanics may properly be added to this list, but the abstract theory of these sciences should be taught under pure mathematics.

The list is necessarily somewhat arbitrary, but it gives an idea of the range of subjects, some of which are indeed difficult to distinguish from the applied sciences to which they form the stepping-stones.

For the sake of clearness we shall mention some of the subjects which are here considered to be outside of the province of theoretical mechanics: theory of structures, hydraulics, dynamics of gases, thermodynamics, acoustics, ballistics, capillarity, etc.

Theoretical mechanics is the foundation of all physical sciences and forms the intermediate link between pure mathematics and the various engineering sciences as well as physics. It is like pure mathematics a fundamental subject in engineering schools; it should be treated as such, and the instruction should proceed along the same lines. First a foundation of the elementary parts of the subject should be given to all students as soon as they have the necessary mathematical preparation, preferably in the freshman year. In the later years the more advanced parts should be taught, each profession being allotted what is necessary for its special purpose, without, however, disrupting the continuity and harmony in the instruction of the science as a whole.

In American engineering or scientific schools theoretical mechanics is rarely taught separately as such, at least, not in a complete manner; in fact, in many cases it does not appear on the schedule at all except in the form of special courses adjusted to the various engineering professions.

Under the heading of physics there is given in many schools a course called mechanics with the specific aim of preparing students for the study of physics. It comprises the most elementary parts of theoretical mechanics, but is not always well suited as a foundation for other subjects, for which purpose it is not directly intended. It is often repeated in a somewhat different and more extended form in the lectures on applied mechanics, being here designed to cover the elementary parts of sections (1) and (2).

In theory of structures, which is in fact a branch of applied mechanics, parts of section (1) are apt to be given. The same is true of certain subjects under electrical engineering. Under hydraulics is given a course in hydrostatics and flow of water.

Advanced parts of theoretical mechanics are often taught not only under the heading of mechanical engineering and of mathematics, but also and perhaps chiefly in physics (higher dynamics, hydrodynamics and elasticity) and in electrical engineering (mechanical forces due to magnetic fields, theory of vibrations, sound waves). Fragments of this science are also taught in the departments of civil engineering (the fundamentals of statically indeterminate structures, plasticity in connection with soil mechanics), in aeronautical engineering (hydrodynamics and aerodynamics) and in naval architecture (wave motion).

This description may not fit all engineering schools in this country but is believed to be fairly representative. On the whole it appears that in the United States theoretical mechanics is too often taught in a scattered way and as a subsidiary science, of which each department gives only what is required for its specific needs without much regard to unification of the science.

The subject is rarely given under its own name and then only in parts. In many cases no special teachers are assigned to it in such a way that they can devote all their energy to it. No one is responsible for imparting to the students a well-rounded course in theoretical mechanics giving a complete presentation of the subject within the limits set by the requirements of the various technological courses.

It is clearly impossible to do justice to a science under these circumstances. Overlappings and gaps in the instruction unavoidably occur, insufficient emphasis is placed on fundamental concepts, and what perhaps is worse, the science suffers in standing and prestige. This must react unfavorably upon the attitude of the students, who can not be expected to realize the importance of a subject the name of which they have perhaps never heard and which is presented to them as an incidental, a handmaid to other sciences.

Turning now to European schools, it appears that ordinarily theoretical mechanics is ranked as equivalent to mathematics in importance and is regarded as one of the corner-stones of engineering education, although certain parts of (1) and (2) may be given under applied mechanics or under mathematics in some schools. Also parts of (3) and (4) are in many cases taught as belonging to the applied sciences. Yet greater portions of this science and especially sections (1) and (2) are quite commonly listed as separate and independent subjects, certainly more so than is ordinarily the case in this country. This is indicated by the names commonly given to the subject. In England it is taught under the names of applied mathematics, theoretical mechanics, analytical mechanics or simply mechanics; in France under the names of mathématique appliquée, mécanique analytique or mécanique rationelle. In Germany it is called angewandte Mathematik, rationelle Mechanik or Mechanik. In the "Handbuch der Physik,"[1] which is a monumental work of twenty-four volumes, theoretical mechanics is shown in its true perspective. The entire subject, as defined above, is here given in volumes V, VI and VII, preceded by a résumé of pure mathematics in Volume III and followed by the works on physics proper.

The remark is often heard that graduates from European technical colleges who continue their studies in this country are better equipped to attack technical problems mathematically than are American students of equal standing. Since many of those European students come over on scholarships, they are probably picked men so that it is difficult to judge whether that statement is true in general, but if it is, it is believed to be due not to superior mental capacity of the European students or to inferior ability of our teachers, but chiefly to the more complete and systematic training which European students get in theoretical mechanics.

The reason why theoretical mechanics has been given such a subordinate position in American engineering schools is not clear, but probably it is due largely to the rapid development of these schools, which have been working under a great pressure from the industry and often under economic difficulties. The demand for results, for turning out young engineers as quickly as possible, has forced the pace.

But conditions are changing, technical colleges do not have to fight so hard for their existence, and moreover, in recent years a great development has taken place in theoretical mechanics, which has acquired greater importance than ever before. We need only refer to the advances made in theory of elasticity and plasticity, in hydrodynamics and aerodynamics and the application of theoretical mechanics to electrical engineering, thermodynamics, acoustics and all branches of theoretical physics. In this connection we may mention some of the names of the many eminent workers in this field: Love, Lamb, Appell, Schrödinger, Heisenberg, Prandtl, von Mises, von Kármán, Levi Civita, Nádaj and Timoshenko.

It is time that theoretical mechanics be given its appropriate place in the curriculum of American engineering schools. As a means of training in scientific methods of thinking and as a mental discipline introductory to research work, the subject is probably unequaled.

One of the foremost German mathematicians, Dr. von Mises, in an introductory article to the *Zeitschrift für angewandte Mathematik und Mechanik* on the occasion of its first issue, made the following statement concerning theoretical mechanics:

> More than any other science it forms an indispensable foundation for creative engineering. Mechanics, which by Leonardo da Vinci was called the paradise of the mathematician, has become for the modern engineer the most comprehensive field of work, the laborious exploitation of which is left almost entirely in his hands, and from which he will reap ample rewards, even although only through hard work.

If properly taught, a course in theoretical mechanics will have great cultural value. A brief historical review of the development of this science should be given, its function as an indispensable tool for progress in all physical sciences and its profound influence on our fundamental scientific concepts should be explained.

Theoretical mechanics should be unified, harmonized and treated, not as a subsidiary, but as a science in its own right and as a fundamental in engineering education, ranking with pure mathematics and physics. It should be listed under its own name, have its own staff of teachers, preferably organized in a special independent department, and should be taught as a separate subject. Laboratories should be available for the department and the teachers should be allowed time for research.

Great as are the achievements of American engineers, it is believed that they will be still greater with such an important improvement in their training. Modern technical development calls for more refined methods of construction and hence more advanced analytical knowledge and more research. Engineers now, more than ever before, are confronted with entirely new problems. They are required to do things that have never been done before, whether in magnitude or in kind, and in such cases, when previous experience fails, they are thrown back on experiments and theoretical analysis, where a thorough knowledge of theoretical mechanics is indispensable.

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[1] H. Geiger and Karl Scheel, 1926–29.

A reform in the engineering schools as here suggested will undoubtedly meet with many obstacles. Administrative arrangements may be somewhat dislocated, text-books may have to be revised, new teachers may have to be engaged and instruction may suffer somewhat in the period of transition, but the course in theoretical mechanics may not need to be longer or more difficult than at present. What is proposed is chiefly a rearrangement of courses, with an addition of such matter as will make the resulting courses, each of them, more self-contained and complete. By avoiding repetitions time will be saved, and by a more complete and logical presentation of the subject, including a full explanation of fundamental concepts, it is believed that it will be easier for the students to grasp. The reform may perhaps be best carried out by an evolutionary process beginning with the establishment of a small department in theoretical mechanics. This department might gradually take over the scattered courses now given under various departments and strengthen them by a process of unification and completion. Thus the department would gradually grow in magnitude and importance. This method may be preferred in particular where the services of a teacher eminent in this science are available, to whom the task of building up the new department can be entrusted.

When fully developed, such a department should have charge of the entire range of subjects specified under sections (1) to (4) above, but besides the classical mechanics it might also properly include wave mechanics and mechanics of relativity. It should work in close cooperation with the department of mathematics on one side and with the various professional courses including physics on the other side.

With the adoption of such a program in the American technical colleges, it should be possible not only to equal but to surpass the achievements of corresponding European institutions.

PLANT QUARANTINE

By Professor E. O. ESSIG

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The idea of quarantine[1] had its inception in connection with the attempts on the part of early Europeans to exclude and prevent the spread of dreaded plague or black death. Venice inaugurated such a restrictive measure as early as 1348, which was followed by other European countries. In spite of the long experience of human health quarantine, England did not establish her first health quarantine until 1710, and delayed in passing the Public Health Act until 1896. Thus we see that many years have been required to perfect the present highly efficient and valuable public health measures now maintained by all the progressive nations of the world, and accepted by all their citizens. It is my firm belief that plant quarantine will, in a much shorter space of time, attain a similar place in the affairs of civilized peoples. Fundamentally it is as sound to protect the plant life of a country from the constant encroachments of insect depredators and plant diseases as it is to protect human health. An abundant and available food supply is as essential to human beings as is health and almost as personal, because it affects the livelihood of every individual, since the prices and availability of food are largely regulated by supply.

In view of the fact that there is so much general misunderstanding regarding plant quarantine, this article is written with the aim of presenting the claims of this young member of the administrative family.

In the first place, quarantine is a police power. This makes it very objectionable to certain minds. Anything that questions the free rights of individuals to act as they please is ever open to criticism. Law enforcement is always a difficult task, and even the most thoroughly qualified, tactful and resourceful official has great difficulty in handling the public as agreeably as is expected. Nearly all the complaints that arise from quarantine originate in regulatory and law-enforcement proceedings. This fact must be recognized at the outset. In this respect quarantine is no different from other measures enforced by due processes of law.

Plant quarantine, like health quarantine, was born of necessity—it was not the child of speculative philosophy, nor was it an ethical experiment. The early introduction into this country of such serious pests as the codling moth, San José scale, citrus scale insects, cotton boll weevil, pear psylla, cabbage worm, gipsy and brown-tail moths and many stored-product and household pests, as well as the rapid dissemination over the land of such native insects as the bean-weevil, chinch bug, Colorado potato beetle, and other pests, were at first looked upon as a matter of course. But when it was learned that our system of agriculture, embodying the production of large areas of single crops, afforded unusually favorable conditions for these pests to propagate and do unheard-of damage, a new idea of insect immigration and migration was conceived on the proposition that exclusion is easier than extermination and cheaper than control!

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[1] The term *quarantine*, literally meaning a period of forty days, was originally designated as the time during which a ship, suspected of being infected with a serious contagious disease, was obliged to refrain from all intercourse with the shore. It has always come under the powers of the police.

With this idea in mind, the first state plant quarantine laws were promulgated and put into execution. The problem appeared easy at first, when there was but little knowledge of world economic entomology, when insect pests were supposed to be largely carried on nursery stock and when domestic and international commerce was slow and concentrated at the larger inland cities and at a comparatively few seaports. As a matter of fact, it was not difficult to enforce the laws as conditions existed then. But commerce developed faster than plant quarantine, which is well illustrated by the fact that a national conception of plant protection did not crystallize until 1912 with the passage of the first National Horticultural Law. This tardiness of action on the part of the government permitted the free entrance into most parts of the country of many insects which seriously tax the agricultural welfare of the nation.

To prevent a continuance of this unwarranted spread of pests, plant quarantine has been thoroughly overhauled and strengthened. A number of important steps were recognized and taken. It was clear that to be effective such legislation should at least provide:

1. For the absolute exclusion of certain serious pests and all articles of commerce likely to carry them from known areas of infestation. This is virtually an embargo.
2. The right to destroy, reject or exclude materials when inspections reveal the presence of insect pests or plant diseases.
3. The right to prescribe restrictions and regulations under which plant materials may be admitted into a region.
4. The power to formulate plans and enforce regulations to confine an insect to a given area and to resist its spread from one district to another.
5. The authority, power and financial means necessary to discover and to exterminate, if possible, a pest newly established in an area.

This is a difficult and complex program which requires expert training, skill and experience. Insects and diseases are carried in many ways. When all these are learned some of the complexities will be removed. Years of careful study will be required to solve many of the problems of pest introduction and to perfect ways and means adequate to meet them.

It is impossible to predict what an insect will do in a new environment. A great many of our worst pests were either unknown or of no economic importance in their native homes. Therefore plant quarantine can never be safely administered as a compromise measure.

In considering the above five points it would appear that complete exclusion is the most important, and at the same time most difficult to enforce. Such exclusive quarantines have been maintained against all products likely to carry pests from various districts throughout the world known to be infested with fruit flies, citrus canker, and the foot and mouth disease of live stock. Plant pests and diseases, as well as human diseases, such as plague, typhus and dysentery, do slip through such quarantine lines, but these failures are shallow arguments that such preventive measures are valueless and should be abandoned. As a result of such regulations the public becomes aware of the danger and the majority of those engaged in commerce or travel will cooperate to enforce the law, thus materially reducing the hazards of unknowingly bringing dangerous pests and diseases into the state or nation. Many of them will also actually assist in law enforcement. In this manner an insect pest may be kept out indefinitely or its entrance greatly delayed. Such delays enable the entomologists to study the insect and devise methods of control. There is every reason to believe that plant quarantine enforcement, together with wide and continued publicity in the form of suitable literature placed in the hands of travelers, have been responsible for the fact that the Mediterranean fruit fly has not already been introduced in sufficient numbers into California from Hawaii to have become established here. The exclusion of the Mexican orange maggot and the cotton boll weevil are other instances which might be cited in this connection. If the insect finally slips through some leak it is more likely to be apprehended than in the days before quarantines were known, and the chances of exterminating it before it becomes widely distributed are very favorable—laws, trained men, improved methods of control, equipment, like a well-trained and equipped army, are immediately available. In the case of health quarantine, plague occasionally enters our seaports in spite of the eternal vigilance of health authorities. Following this introduction an extermination campaign, at whatever cost, eventually conquers it, and no one questions the expense. And now and then a disease, like influenza, slips through the ports and sweeps over the whole country. Does any one wish to abolish health quarantine because of such lapses?

In the early history of plant quarantine, inspection was the sole basis of admission or rejection of plant materials and is still an important part of present-day procedure, particularly in dealing with intersectional, intercounty, and interstate movements of agricultural products. Inspection can never be 100 per cent. efficient because of the human limitations of the men doing the work. Yet it is the only means whereby produce can be moved with a degree of safety without paralyzing commerce. That very many serious pests are intercepted in this way is another indication that quarantine measures reduce the number of foci of infestation and thus delay a rapid spread over the entire country. Inspectors become more proficient and experienced from year to year, and it is to be expected that the service will thus be gradually improved.

The right to prescribe restrictions and regulations governing the admission of certain products results in no great inconvenience to the shipper and sets up safeguards for the protection of large districts against certain serious pests. Such safeguards in the form of restrictions and regulations are usually agreed upon before legal steps are taken, and all the cases I know of are carried out harmoniously and greatly to the benefit of all concerned. They furnish real financial incentives for those in infested areas to reduce the offending pests to the lowest possible minimum in order to secure more favorable regulations, or, as in some cases, to cause them to be entirely withdrawn.

Circumscribing certain areas within a given part of the country which may be infested with a serious pest or disease is an important prerogative of quarantine. This method is commonly employed and is at the present time in force against the gipsy and brown-tail moths, Japanese beetle, European corn borer, date palm scales, Mediterranean fruit fly, citrus canker and similar insects and plant diseases. The idea is to prevent the artificial spread of such pests throughout the country by defining boundaries across which articles of commerce most likely to carry the pest can not proceed. In the meantime everything is done through the employment of artificial and biological methods of control to reduce the infestation and thereby reduce the natural spread, which can not be stopped by legal processes of law. In this manner it is much more difficult for any of these pests to jump across the continent with plant products or other materials sent by mail, express or freight, or carried in private automobiles. As illustrations we might cite the cases of the gipsy and brown-tail moths, the Japanese beetle and the alfalfa weevil. All are gradually and slowly enlarging their boundaries, but none of them have been able to make long-range establishments throughout the country. During the period of restriction all the more important facts concerning the life habits and control of all these pests have been ascertained and distributed throughout the country for the free use of all the people in meeting any like emergencies elsewhere. In these modern times the chances of distributing pests by means of automobiles and even aeroplanes offer probably the greatest hazards now faced by quarantine officials and thoroughly justify the entirely inadequate inspection stations found at some state and national boundary lines. When the private individual is aware of the importance of this service, the necessity for it will be greatly reduced and the inconvenience caused accepted without undue criticism.

The extermination of a serious pest, once thoroughly and permanently established in a new district, is a question of very great importance, not only to the industries involved at the present time, but also to untold generations to come. It has often been argued that when once thoroughly established an insect pest can not be eradicated. This fallacious statement has been based upon a few half-hearted and inadequately and tardily financed attempts which were doomed to failure at the beginning. Eradication is possible if we as a county, state or nation are willing to pay the price. In this connection it might be well to call attention to the fact that quarantine officials in California have already discovered initial infestations of several newly introduced pests, including the pecan leaf case bearer, the rough strawberry weevil and the citrus white fly, and have apparently successfully eradicated them at a cost so surprisingly low as to call forth no criticisms whatsoever. It now looks as though the campaign against citrus canker is also a case in point. The present campaign against the newly established Mediterranean fruit fly in Florida promises to furnish a glorious example of man's ability actually to exterminate a serious insect pest established over a large territory. Only the obstructionists can prevent its final consummation.

Imagine if you can an area comprising some 1,500,000 acres of fruit trees stretching across nine states with a total valuation of approximately $1,800,000,000 and an annual crop worth $240,000,000. This is the area and investment that is subject to possible injury and financial embarrassment by the Mediterranean fruit fly. No one will deny the right of the owners of these orchards to demand protection from the invasion of any insect pest which will add to the great expense already necessary to produce, harvest and market such a valuable crop. The comparatively small sum of $4,250,000 was appropriated to safeguard this great industry, which in reality belongs to the nation as a whole. It has been spent as wisely as possible in an intensely important and feverish campaign conducted in a few months. The situation has been under orderly and complete control throughout the undertaking. The job has not been completed. No one acquainted with the problem expected it to be finished short of at least two cropping seasons. More money is needed to finish the task. Instead of an adequate appropriation to continue this work, $1,000,000 only has been made available. If this amount is not sufficient then other funds must be obtained, because this is one case where the actual financial considerations involved thoroughly justify the expenditure of large sums. This is a national problem and should be met as such. To embarrass financially or to ruin the fruit growers of Florida to accomplish the end in view not only is unjust, but might also result in the defeat of the project. Without the whole-hearted and sympathetic cooperation of these orchardists we can not hope to destroy the very last fly.

Plant quarantine truly seeks to protect the agricultural resources for all the people. I refer to agriculture because the farmers more than any other class of people have been imposed upon by these foreign insect foes. They have been compelled to suffer great financial losses and to fight a continual and expensive campaign against insect pests and plant diseases. There is no discrimination on the part of the pest; every crop in every section of the continent is subject to their unrelenting attacks which result in absolute waste and therefore loss to the well-being of the entire country.

Is it any wonder then that the farmers have been positive in their demands for protection against additional hordes of insect pests? And even though many of the latter have already invaded the fields and orchards, are we not justified in our requests to close up the leaks and keep the others out? Plant quarantine can do this with proper legislation, judicious law enforcement, adequate financial support and the sympathetic cooperation of a well-informed public. It can never be absolute, but it can be made to meet the agricultural needs of this country through capable and determined supervision.

Are we as a people to stand aside and watch the continued procession of destructive pests file into our country, sweep over our fields, orchards and forests, destroy our live stock and invade our very homes on the shallow assumption that we are helpless because of certain uncontrollable biological factors? Or shall we challenge their right to such free aggressions by the enactment and enforcement of adequate plant quarantine measures?

OBITUARY

RECENT DEATHS

Dr. J. R. Guthrie, dean emeritus of the medical school of the University of Iowa, died on March 14, at the age of seventy-two years.

Henry R. Howland, formerly president of the American Association of Museums and for sixty years member of the board of managers of the Buffalo Society of Natural Sciences, died at Buffalo on February 4, at the age of eighty-five years.

Dana Jackson Leffingwell, for the past three and one half years assistant professor of zoology and curator of the Charles R. Conner Museum of the State College of Washington, died on March 7 at the age of twenty-nine years. A correspondent writes: "Dr. Leffingwell was educated at Cornell University, from which institution he received the doctorate in philosophy in 1926. His greatest interest was in the field of ornithology, particularly the study of game birds, although this interest was extended to all branches of natural history. He was a keen student of wild life and of conservation. For the past three summers he had been employed by the New York State Conservation Commission engaged in making a survey of the food resources of the streams of the state."

Professor Augustine Henry, forestry expert and botanist, died in Dublin on March 23, at the age of seventy-two years. He had been professor of forestry in University College, Dublin, since 1926. During eighteen years' residence in China, as an official of the Chinese Imperial Maritime Customs, he became interested in botany, later becoming an authority in this field.

Dr. Kennedy Joseph Previté Orton, F.R.S., professor of chemistry in the University College of North Wales, died on March 16, in his fifty-eighth year.

Professor Giovanni Mingazzini, director of the psychiatric clinic of the University of Rome, died suddenly at the age of seventy years. He was the author of numerous publications on anatomical and physiological subjects and on the pathology of the nervous system.

MEMORIALS

A memorial meeting in honor of the late Dr. Richard Mills Pearce, Jr., will be held on April 15 at 4 P. M. at the Rockefeller Institute for Medical Research. The speakers will be Mr. George E. Vincent, president of the Rockefeller Foundation, 1916–1929; Dr. David L. Edsall, dean of the Harvard University Medical School; Dr. Howard T. Karsner, professor of pathology at Western Reserve University, and Dr. Simon Flexner, director of the Rockefeller Institute.

THE Senate has adopted a resolution authorizing the erection of a monument costing $50,000 in Washington to Major-General William Crawford Gorgas, formerly surgeon-general of the army, in honor of his work on yellow fever at Havana, the Panama Canal Zone and Guayaquil, Ecuador.

A PORTRAIT of the late Professor Rolla C. Carpenter, of Cornell University, painted by Professor Olaf Brauner at the instance of a group of alumni headed by Eugene C. Sickles, has been accepted by the trustees and hung in the office of the Sibley School of Mechanical Engineering.

A HARVEY MEMORIAL FUND is being raised by English physicians as a token of respect for the demonstrator of the circulation of the blood and the founder of modern physiology. Americans who desire to contribute may do so by sending a check made out to the fund to Dr. Arnold W. Stott, 58 Harley Street, W.I., London. It is planned to erect a tower on Hempstead Church, where William Harvey is buried.

SCIENTIFIC EVENTS

THE CENTENARY OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

WHEN the British Association for the Advancement of Science holds its centenary meeting in London next year it is practically assured that the presidential address will be given by General Smuts. The council of the association has resolved to nominate the South African statesman as president for 1931, and General Smuts has accepted the nomination, which in the ordinary way will be submitted to the general committee.

The British Association, since its foundation in 1831, has never held its annual meeting in London. The first meeting was held at York, which was chosen as being "the most central city in the three kingdoms." Consideration was given to the possibility of returning to York for the centenary gathering, but in view of an expectation that this meeting will be unusually large there was doubt if the necessary accommodation could be found in the Yorkshire city, and the general committee decided unanimously at the Glasgow meeting in 1928 that it would be suitable and appropriate to hold the centenary meeting in London, the center of the Empire.

It is interesting to note in connection with the matter of hotels and other facilities for housing members of the association, that in 1831 Sir David Brewster wrote to John Phillips, the secretary of the Yorkshire Philosophical Society, asking him to ascertain "if York will furnish the accommodations for so large a meeting, which might perhaps consist of above 100 individuals." The hospitality apparently proved to be satisfactory, as later meetings were held at York in 1844, 1881 and 1906. It is likely, however, that several thousands of members will attend in London.

If General Smuts becomes the president of the London meeting he will be the first president elected from one of the great Dominions of the Empire. British statesmen have on several occasions held the position. The first president was Viscount Milton, M.P. for Yorkshire, and a supporter of Parliamentary reform and free trade. The third Marquess of Lansdowne presided at Bristol in 1836; the Duke of Northumberland was president in 1838; the Marquess of Salisbury between two periods of office as prime minister presided at Oxford in 1894, and at the Cambridge meeting in 1904 the late Lord Balfour was the president. The Prince of Wales gave the presidential address at Oxford in 1926. General Smuts took a prominent part in the South African meetings of the association last year and expounded at Cape Town his theory of "Holism."

The British Association this year will meet at Bristol under the presidency of Dr. F. O. Bower, Regius professor of botany in the University of Glasgow.

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[1] From the London *Times*.

REFORESTATION IN NEW YORK STATE

ACCORDING to the New York *Times* the state's project for spending $20,000,000 in the next fifteen years to plant new forests on abandoned farm lands won almost unanimous approval at a public hearing on March 12 on the proposed constitutional amendment sponsored by the State Reforestation Commission.

The only opposition came from the Association for the Protection of the Adirondacks, in a letter signed by John G. Agar, its president, and filed with the Senate Judiciary Committee, before which the hearing was held.

The objections set forth in Mr. Agar's letter were as follows:

> 1. Because the proposed constitutional amendment, sponsored by Senator Hewitt, of Cayuga, called for a definite amount to be expended annually over a period of years, and this might cause embarrassment to the state treasury.
>
> 2. Because the prohibition against lumbering or inter-

ference with the wild condition of the state's forest lands outside of the Adirondack and Catskill Parks should not be removed.

3. Because the policy embodied in the Hewitt bill called for the expenditure of money for reforestation purposes exclusively in territory *outside* the forest preserve.

4. Because the proposed amendment omitted any provision that lands now owned or to be acquired by the state for forest preserve purposes should forever remain "wild forest lands." Mr. Agar thought that this omission might be construed as evidence that the state had changed its policy regarding such holdings.

To meet this latter objection, which was viewed by members of the State Reforestation Commission in attendance at the meeting as the most vital objection advanced by Agar, the commission authorized an amendment, which was presented to the committee. This amendment excluded all the language in that section to which Mr. Agar had objected and substituted the following:

> The lands of the state, now owned or hereafter to be acquired, constituting the forest preserve, as now fixed by law, shall be forever kept as wild forest lands. They shall not be leased, sold or exchanged, or be taken by any corporation, public or private, nor shall the timber thereon be sold, removed or destroyed.

Regarding the objection having to do with the possible lifting of the prohibition against lumbering in forest preserves outside Adirondack and Catskill Parks, former Senator Lusk, counsel for the commission, said the commission had no intention of countenancing any relaxation of present prohibitions, even though in the opinion of many experts this would be in line with the most advanced policy of forestation pursued by European nations.

The question of whether the present policy of the state with regard to its forest lands should not be superseded by one permitting restricted lumbering was raised by George A. Lawyer, of Watertown, managing director of the State Development Association.

Mr. Lawyer urged that the Hewitt amendment be so changed as to open the way for restricted lumbering, at least outside the state parks. This would leave the 5,177 square miles within the "blue line" unmolested.

Other speakers at the hearing were Professor George F. Warren, of Cornell University; Professor Nelson C. Brown, of Syracuse University; Professor A. B. Recknagel, representing the Empire State Forest Products Association; Frank P. Myers, of New York, of the Society of American Foresters; J. R. Simmons, of the New York State Forestry Association; Thomas F. Luther, of Saratoga; Conservation Commissioner Alexander MacDonald, and William G. Howard, superintendent of lands and forests in charge of reforestation.

THE PEARL-OYSTER RESOURCES OF THE HAWAIIAN ISLANDS

AT the request of the commissioner of fisheries, the Navy Department on January 15 assigned the U. S. S. *Whippoorwill* to assist the Bureau of Fisheries in a hydrobiological survey of Pearl and Hermes Reef, Hawaii, from July 15 to September 1. Dr. P. S. Galtsoff, who will be in charge of the expedition, is engaged in assembling equipment and completing the plans for a four-month investigation.

In the spring of 1928, a colony of pearl oysters was discovered by fishermen in the lagoon of Pearl and Hermes Reef, some 1,200 miles northwest of Honolulu. Although the discovery was kept a secret for some time, several concerns engaged in active fishing of the pearl shells which yield the mother-of-pearl of commerce as well as valuable jewels. With no reliable information as to the extent of the pearl-oyster beds, concern was felt for their destruction before regulatory measures could be devised. The governor of Hawaii requested the Bureau of Fisheries to conduct a survey to determine the extent of the beds and what measures should be taken to perpetuate them or to increase production by artificial means. Failing to secure a special appropriation from Congress for that purpose, the territorial legislature at its last session appropriated a fund for defraying the expenses of an investigation by bureau employees. With the action of the Navy Department in providing a ship for the purpose, a preliminary survey is now made possible.

Because of the remoteness of Pearl and Hermes Reef and the impracticability of maintaining close patrol of this section of the Hawaiian Archipelago, the plan has been proposed of developing a pearl fishery in other localities and for cultivating pearl oysters somewhere on the island of Oahu, or on other islands of the eastern group. Since pearl-oyster beds formerly existed at Pearl Harbor, near Honolulu, the plan seems feasible provided a supply of oysters can be brought from known beds in Pearl and Hermes lagoon for stocking purposes. This plan requires a preliminary hydrobiological survey of local waters and an arrangement for the establishment of oyster farms in selected localities under the supervision of territorial authorities. Dr. Galtsoff plans to carry out this local survey in June and during the first half of July, with the cooperation of the territorial board of commissioners, and to complete the survey of Pearl and Hermes Reef and intervening atolls and lagoons before the stormy season begins in September.

THE FIELD COLUMBIAN MUSEUM

THE annual report of the director of Field Museum of Natural History for 1929, a 265-page volume illustrated with twenty photogravure plates, has been published by Field Museum Press. The book contains a review of the manifold activities of the institution both at home and by its many expeditions abroad, as presented before the museum's board of trustees by Stephen C. Simms, the director.

Among large gifts received by the museum during the year are $165,567 from Marshall Field, of New York; $110,079 from Stanley Field, president of the museum; $20,000 from Frederick H. Rawson; $50,000 from the late Mrs. Julius Rosenwald; a bequest of $50,000 from the late Chauncey Keep; $15,000 from the Rockefeller Foundation; an anonymous contribution of $12,500; $10,000 from Samuel Insull; $5,000 from Silas H. Strawn; a bequest of $5,000 provided by the late Katherine L. Andrin, and various sums from William J. Chalmers, Mrs. James Nelson Raymond, Richard T. Crane, Jr., the American Friends of China and Martin G. Schwab.

The museum's operating deficit for the year was $108,274.

Mr. Simms shows that the museum received 1,168,430 visitors during 1929, exceeding the records of all previous years. This was the third successive year in which attendance was more than one million. 1,363 new names were added to the museum's membership rolls during the year, bringing the total number of members contributing to the institution's support to 5,781.

The two units of the museum devoted to work among school children carried on large scale activities during 1929. More than 250,000 children were reached by the motion pictures, lectures and other educational programs provided by the James Nelson and Anna Louise Raymond Public School and Children's Lecture Division. Some 500,000 children received supplementary instruction throughout the school year by more than 1,100 traveling exhibits circulated among the schools and other centers by the N. W. Harris Public School Extension Department. Illustrated lectures on science and travel for adults provided by the museum were attended by 33,583 persons.

The report contains detailed accounts of the work of seventeen expeditions which the museum had in operation in many far parts of the world during 1929. Outstanding among these were the William V. Kelley-Roosevelt Expedition to Eastern Asia led by Colonel Theodore Roosevelt and Kermit Roosevelt; the Cornelius Crane Pacific Expedition sponsored and led by Cornelius Crane; the Frederick H. Rawson-Field Museum Ethnological Expedition to West Africa; the Chancellor-Stuart-Field Museum Expedition to the South Pacific; the Marshall Field Botanical Expedition to the Amazon; the Field Museum-Oxford University Joint Expedition to Mesopotamia, which completed its seventh season of excavations on the site of the ancient Sumerian city of Kish; the Field Museum-Williamson Undersea Expedition to the Bahamas; the Harold White-John Coats Abyssinian Expedition; the Thorne-Graves-Field Museum Arctic Expedition, and the second Marshall Field Archeological Expedition to British Honduras.

Many new exhibits—anthropological, botanical, geological and zoological—were installed during the year. One of special importance, because there is nothing else like it in any museum of the world, is a life-size restoration of a Neanderthal family and the cave they lived in some 50,000 years ago. The group is a gift from Ernest R. Graham, and was made by Frederick H. Blaschke, sculptor. During the year an extensive program of reinstallations and improvements of exhibition halls was carried on.

Many gifts of rare and valuable material for addition to the collections were received, among the donors being Colonel A. A. Sprague, Richard T. Crane, Jr., William J. Chalmers, Lord Astor, Mrs. John Alden Carpenter, Frederick H. Rawson, Mrs. Joseph W. Work, Julian Armstrong, Earle H. Reynolds, Dr. I. W. Drummond, Dr. W. J. Cameron, Homer E. Sargent, Former Judge George Bedford, Mr. and Mrs. William Bower, Franklin Bower, Henry J. Gebauer and Herbert J. Devine.

THE TUCSON MEETING OF THE SOUTHWESTERN DIVISION OF THE AMERICAN ASSOCIATION

THE annual meeting of the Southwestern Division of the American Association will be held at Tucson, Arizona, from April 21 to 25. It will be the fifth joint meeting of the Southwestern and Pacific Divisions. The program will be arranged in three sections: the biological sciences, the physical sciences, and the social sciences.

On Monday, April 21, there will be a luncheon symposium on "Solar and Terrestrial Relations Including Heliotherapy," to be arranged by Dr. Allen K. Krause, director of the Desert Sanatorium and Research Institute; Dr. A. E. Douglass, director of the Steward Observatory, University of Arizona, and Dr. R. J. Leonard, of the department of geology of the University of Arizona. The afternoon will be devoted to section meetings. The second John Wesley Powell Lecture will be given in the evening by Dr. Rodney Howard True, head of the department of botany and director of the Botanic Garden of the University of Pennsylvania.

On Tuesday, April 22, section meetings will be held both morning and afternoon. A luncheon symposium considering "Desert Life" will be arranged by Dr. H. L. Shantz, president of the University of Arizona. The program for the evening meeting has not yet been announced.

On Wednesday, April 23, section meetings will be held in the morning and afternoon. Dr. Byron Cummings, director of the Arizona State Museum, University of Arizona, will have charge of a luncheon symposium for a discussion of the economic welfare of scientific men. The annual banquet will be held in the evening, at which time Dr. Francis Ramaley, head of the department of biology of the University of Colorado, will deliver the retiring president's address.

The installation of Dr. H. L. Shantz as the president of the University of Arizona will take place on Thursday, April 24. In the morning there will be a symposium on "Opportunities and Responsibilities of the University of Arizona," when addresses will be given on "The University and Natural Resources," by Dr. George Otis Smith, of the U. S. Geological Survey; "Beauty in American Life," by Lorado Taft, and "The Unity of Nature as Illustrated by the Grand Canyon," by Dr. John C. Merriam, president of the Carnegie Institution. The installation ceremonies will take place in the afternoon, when Dr. Shantz will deliver his inaugural address.

On April 25, field trips will be arranged to points of scientific interest in the vicinity of Tucson, and on Saturday, April 26, there will be held a conference on "Forest, Wild Life and Range Problems."

Interesting and instructive exhibits of technical apparatus will be made by scientific instrument companies. In addition, special preparations are being made for exhibits illustrative of the art of the desert and its archeological resources, as well as some noteworthy features of its plant and animal life.

The Ecological Society of America will have a special program at the Tucson meeting, and several ecological field trips are being planned.

One fare and a half will be in effect under the certificate plan, providing that one hundred and fifty tickets are purchased for the meeting. It is expected that there will be at least this many in attendance. The Santa Rita Hotel has been designated as headquarters. Hotel reservations should be made as early as possible.

SCIENTIFIC NOTES AND NEWS

Dr. Karl T. Compton, professor of physics in Princeton University, will be installed as eleventh president of the Massachusetts Institute of Technology on the afternoon of June 6. Following the inauguration ceremony, Dr. Samuel W. Stratton, for the past eight years president of the institute, now to be chairman of the executive committee of the corporation, will hold a reception with members of the corporation for Dr. Compton at the president's house. Dr. Stratton and Dr. Compton will speak at the reunion banquet of more than 2,000 alumni on the evening of June 7. Sir William H. Bragg, of the Royal Institution of Great Britain, will be the commencement orator at the graduation exercises on June 10.

A luncheon was given in Washington on March 27 by Mrs. James C. Pilling in honor of the eighty-sixth birthday of Major-General A. W. Greely. The other "ranking guest" was Brigadier-General David L. Brainard, who was one of the twenty-five men accompanying the Greely Arctic Expedition in 1881.

Dean Mortimer E. Cooley, past president of the American Engineering Council, was presented with the Washington Award for 1930 in Chicago on February 24, "for vision and constructive leadership in the education of the engineer." The principal address was by Dr. Howard McClenahan, secretary of the Franklin Institute, and greetings were extended from the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. The presentation of the award was made by Mr. William S. Monroe, president of the Western Society of Engineers.

Dr. Hugo Eckener received the gold medal of the National Geographic Society on March 27. The inscription on the medal reads: "This special medal of the National Geographic Society is awarded to Hugo Eckener for his work in furthering the progress of airships and to commemorate the first around-the-world flight of the *Graf Zeppelin* in 1929 under his command."

According to the *Christian Science Monitor* a wood named in honor of Albert Einstein has been inaugurated in the Jewish Colony of Dilb near Jerusalem. The Jewish National Fund is planting a forest beginning with 10,000 trees. Eight trees ceremoniously planted include one on behalf of the National Fund, the Jewish Agency, the German Reich, the Hebrew University, the Jewish Community in Palestine and the Agricultural Group, which will look after the planting.

Dr. Alexander Wetmore, assistant secretary of the Smithsonian Institution, has been elected an honorary member of the Deutsche ornithologische Gesellschaft, and a foreign member of the British Ornithologists' Union.

Dr. Frank C. Baker, of the University of Illinois, was recently elected a corresponding member of the Zoological Society of London.

Dr. Jean Charcot has been elected a member of the Paris Academy of Sciences in the section of *membres libres* for those who have rendered service to the art of medicine.

At the annual general meeting of the British Institute of Chemistry, Dr. G. C. Clayton was elected president in succession to Professor Arthur Smithells. The Meldola Medal was awarded to Dr. R. A. Morton, of Liverpool, and the Sir Edward Frankland Medal and Prize to Mr. B. W. Bradford.

Royal Medals of the Royal Geographical Society have been awarded as follows: Founder's Medal to Mr. F. Kingdon Ward, for his geographical explorations and work on botanical distribution in southwest China and southeast Tibet. Patron's Medal to Mr. C. E. Borchgrevink, for his pioneer Antarctic Expedition of 1898 to 1900, which was the first to winter in the Antarctic, to travel on the Ross Barrier and to obtain proof of its recession. The council has made the following awards: Victoria Medal to M. Emmanuel de Margerie, for his distinguished contributions to the science of land forms; Murchison Grant to Colonel H. Wood, R.E., for his surveys with the Tibet Mission and the De Filippi Expedition to Central Asia; Back Grant to Mrs. Gordon-Gallien, for her expedition to the Kalambo Falls; Cuthbert Peek Grant to Mr. Owen Lattimore, for his travels in Mongolia and Chinese Turkestan, and the Gill Memorial to Lieutenant-Colonel Reginald Schomberg, D.S.O., for his explorations in the Tarim Basin and the Tien-Shan.

Dr. Edgar Allen, who has been professor of anatomy in the University of Missouri since 1923, has been appointed dean of the faculty of medicine and director of the university hospitals at the University of Missouri. Dr. Allen succeeds Dean Guy L. Noyes, who died on February 4. Dr. Noyes had been a member of the faculty of medicine since 1902 and dean since 1917.

Dr. J. J. Weigle, associate professor of physics at the University of Pittsburgh, has been appointed, effective October, 1930, professor of physics and director of the laboratory at the University of Geneva, Switzerland.

W. B. Bollen, after five years' service as assistant chemist at the Idaho Agricultural Experiment Station, has been appointed assistant professor of bacteriology and associate bacteriologist at the Oregon State College and Experiment Station, Corvallis, where he has charge of teaching and research work in soil bacteriology.

Dr. Frederick J. Cullen, medical officer in the U. S. Department of Agriculture, has been selected to head the drug control work of the department's food, drug and insecticide administration. This appointment fills the vacancy caused by the resignation of Dr. James J. Durrett to become state health officer of Alabama.

Dr. J. W. Whitaker, senior lecturer in applied science in the department of mining, University College, Nottingham, has been appointed principal of the college. He is the author of a number of publications on mining, chemistry and physics.

Professor J. Arthur Thomson will resign the chair of natural history (zoology) in the University of Aberdeen as from September 30.

Alois Paikert de Sepros, formerly Royal Hungarian Agricultural Commissioner, accredited to the governments at Washington and Ottawa, has been appointed the first director general of the newly organized Museum of Agriculture at Cairo, through which the palace of the late Princess Fatima has been bought for the nation.

Dr. Robert DeC. Ward, professor of climatology at Harvard University, has been appointed a member of the International Climatological Commission.

At the request of Dr. Waldemar Kaempffert, director of the Museum of Science and Industry, Chicago, the American Engineering Council has appointed Professor Mortimer E. Cooley, dean emeritus of the School of Engineering of the University of Michigan; Edward L. Ryerson, Chicago, Illinois, and Joseph Roe, New York City, to be its representatives on the advisory board of the museum now being planned in Chicago.

At the invitation of the League of Nations, Dr. Remington Kellogg, chairman of the technical committee of the Council for the Conservation of Whales, under the auspices of the American Society of Mammalogists, and a member of the staff of the Smithsonian Institution, sailed for Rotterdam on March 24. The league held a session on April 3 on the subject of whaling and on practical methods of conserving the supply, and Dr. Kellogg attended in the capacity of advisory expert, representing the council. After this session Dr. Kellogg plans to visit European museums, chiefly for the purpose of studying their cetacean material.

Dr. C. Judson Herrick, of the University of Chicago, will spend the spring and early summer at the Effingham B. Morris Biological Farm of the Wistar Institute of Anatomy.

Dr. H. H. Donaldson, of the Wistar Institute of Anatomy, will leave early in June for Europe, where he will remain until September. He plans to be present at the Anatomical Congress in Amsterdam.

Mrs. Agnes Chase, associate botanist in the grass herbarium of the U. S. National Museum, is now collecting in Matto Grosso, Brazil. After visiting Diamantina (Minas Geraes), a historic botanical collecting ground, she went south into São Paulo and then west on the railroad across Matto Grosso to Puerto Esperanca.

Professor Douglas Johnson, of Columbia University, recently returned from a journey of nine months largely devoted to geologic and geographic studies in the southern hemisphere and the Orient. In January and February he spent several weeks examining elevated shore platforms on portions of the Japanese, Hawaiian and California coasts. In Honolulu he addressed the Hawaiian Academy of Sciences on "Interpretations of Shore Scenery," and at Stanford University lectured before the students of the geological department on "The Origin of Certain Supposed Eustatic Shore Benches." On his way east, Professor Johnson spoke on coastal problems before the geological students of the University of Arizona, addressed a general assembly of students at the University of New Mexico and delivered two lectures at Denison University, Ohio.

Professor W. H. Twenhofel, of the department of geology at the University of Wisconsin, will make a lecture tour of the southwest early in April to discuss the origin and constitution of limestone in related rocks and the influence of climate and topography on sedimentation. He will speak at Wichita, April 7; Oklahoma City, April 8; Tulsa, April 9; Fort Worth, April 10, and St. Angelo, April 12, under the auspices of the geological societies of these cities.

The annual address complimentary to the Michigan Academy of Sciences on behalf of the University of Michigan, delivered by Professor Charles P. Berkey, was entitled "With a Geologist in the Gobi Desert." This address was delivered on March 21 at the University of Michigan, where the academy was in session. On the same day Dr. Berkey gave an address on the general subject "Geological Engineering Projects." Both lectures were illustrated.

Royal Canadian Institute lectures during the past month include: Mr. Walter Granger, chief paleontologist and second-in-command, Central Asiatic Expeditions of the American Museum of Natural History, "Gobi Trails"; Professor J. Stanley Gardiner, professor of zoology and comparative anatomy, University of Cambridge, England, "Coral Reefs," and Professor Bradley Stoughton, head of the department of metallurgical engineering, Lehigh University, "Materials for Aircraft Construction."

Science Service has arranged a series of radio talks to be given on Friday afternoons over the Columbia Broadcasting System. The talks will be given from 3:45 to 4:00 P. M., eastern standard time. Following is the program for April: April 4; Dr. Paul R. Heyl, physicist, U. S. Bureau of Standards, "Measuring the Earth's Attraction." April 11; Dean Edward W. Berry, professor of paleontology, Johns Hopkins University, "The Ancestry of our Trees." April 18; Dr. C. G. Abbot, secretary of the Smithsonian Institution, "The Sun and Ourselves." April 25; Dr. Arthur H. Compton, professor of physics, the University of Chicago, "What is Light?"

Dr. Charles Singer, lecturer in the history of medicine of the University of London, will give two courses in the department of zoology in the summer session of the University of California, from June 30 to August 9. The courses will be a historical introduction to biology and a seminar in the history of science.

The C. J. Symons Memorial Lecture of the Royal Meteorological Society was delivered on March 19, by Dr. Herbert Lapworth, who spoke on "Meteorology and Water Supply."

The sixtieth annual meeting of the Wisconsin Academy of Sciences, Arts and Letters will be held at the University of Wisconsin on April 11 and 12. Many of the discussions, which will be illustrated, will be of popular and public interest. Meeting jointly with the academy will be the Wisconsin Archeological Society and the Midwest Museums Conference. Several hundred museums in five states will be represented at the conference.

The forty-fourth annual meeting of the Iowa Academy of Science will be held at Iowa State College on May 2 and 3, under the presidency of L. B. Spinney, head of the department of physics at Iowa State College.

The twenty-fifth annual meeting of the American Association of Museums will be held at Buffalo from June 4 to 7. The first three days will be devoted to business, and the fourth day to visiting places of interest in the vicinity of Buffalo.

An Associated Press dispatch from Berlin on March 27 reads as follows: "Professor Albert Einstein has presented to the Prussian Academy of Sciences a new paper which he has written with Dr. W. Mayer on two strictly static solutions of the field equations of his uniform field theory, which connects gravitation and electricity. These solutions were described as follows: These field equations can be rigorously solved in two cases. The first case is that of a spherically symmetrical field in space, for example, the external field of an electrically charged sphere of fixed mass. The other case is that of the static field of any number of uncharged mass particles at rest with respect to one another."

The $6,900,000 appropriation for combating the Mediterranean fruit fly in Florida, which has passed the Senate and is now in conference, may be subjected to another drastic cut at the hands of the House members. The Senate passed the reduced amount recommended by the President only with the understanding that the House members who held hearings in Florida on the fruit fly situation should pass upon the item and reduce it still further if they thought it too large. In the meantime, the federal field inspection force in Florida has had to be reduced by 600, with the prospect of still further dismissals.

A bill introduced in Congress by Representative Griffin, of New York, would provide a medal of honor for government workers who do distinguished work along scientific lines. The bill provides that recommendations of not more than five persons each year would be made to the President by a commission representing the National Academy of Sciences, the American Association for the Advancement of Science and the American Engineering Council. This medal, to be known as the Jefferson Medal of Honor for Distinguished Work in Science, would carry with it a payment of one hundred dollars, and a further annual payment of between one and five hundred dollars.

Alpha Eta Chapter of Phi Sigma, national biological research society, was installed at the Oklahoma Agricultural and Mechanical College at Stillwater on March 13.

A chapter of the Beta Beta Beta, biological fraternity, was installed at Carthage College, Illinois, on February 27. Dr. Arthur C. Walton, professor of biology at Knox College, was the installing officer.

The Paul Herbst collection of Chilian Hymenoptera, which was purchased by a friend for the Museum of Comparative Zoology of Harvard University, has arrived in excellent condition. It is particularly rich in bees and contains a number of types.

A total sum of $5,000,000 in gifts by Julius Rosenwald, philanthropist, removes the last obstacle to the Museum of Science and Industry of Chicago. The museum will be in the reconstructed Fine Arts Building in Jackson Park. A brief was filed in answer to a suit seeking an injunction to stop the project on the ground that the South Park Commissioners violated the law in issuing $5,000,000 in bonds for the reconstruction of the building which later will be used by a private corporation. Mr. Rosenwald's original contribution of $3,000,000 was to equip the museum, the brief stated. An additional donation of between $1,500,000 and $2,000,000 is to be given by Mr. Rosenwald for construction.

The creation of the Lois Grunow Memorial Foundation, for the furtherance of medical science, has been made possible by a gift of $1,000,000 from Mr. William C. Grunow, of Chicago, in memory of his daughter. It is planned to establish a clinical laboratories at Phoenix, Arizona, where Mr. Grunow spends the summers.

The late Mrs. Elizabeth R. Stevens, of Swansea, Massachusetts, who died on February 4, bequeathed $100,000 to Harvard College.

The La Follette bill to appropriate $900,000 for the construction by the government of a forest products laboratory on land to be donated by the University of Wisconsin at Madison was passed by the Senate on March 25.

Provision for the modernization of the U. S. Naval Observatory in Washington, D. C., is made in a bill which was ordered favorably reported by the House Committee on Naval Affairs on March 25. The bill authorizes appropriations as follows: Purchase and installation of equipment, utilities and appurtenances for astrographic and research work and modernization of the astronomical plant, $160,000; construction of astrographic laboratory, $65,000; construction of a service building, $40,000; total, $265,000.

The last state legislature appropriated $335,000 to be used for the construction and equipment of a chemistry annex at the University of Illinois, and the first contracts have been awarded. The annex has been designed to house laboratories, class and storerooms for the elementary chemistry courses, as well as offices for the administrative staff of the division and members of the instructional staff. It will stand between the present chemistry building and the old agricultural building, and will be connected directly with the old agricultural building to permit remodeling of the north wing for use as a chemistry laboratory. The new building will be 200 feet long and 50 feet wide, with three floors in addition to the basement.

The New York State Legislature has appropriated $285,000 for the erection of a laboratory building at the New York State Agricultural Experiment Station at Geneva. This building will house the divisions of horticulture and botany and will make possible the expansion of the other research divisions which will remain in the old laboratory buildings. It is expected that additional funds for equipment will be made available later.

Nature states that at the ninth annual dinner of the London section of the British Association of Chemists, held on March 1, Sir Arnold Wilson outlined a scheme which is now under consideration for a building to house the principal societies and institutions in London concerned with chemistry and chemical industry or related to them. The societies interested are the Institution of Mining and Metallurgy, the Institution of Mining Engineers, the Chemical Society, the Society of Chemical Industry, the Institution of Chemical Engineers, the Institution of Rubber Industry, the Institution of Petroleum Technologists, the Institute of Fuel, the Institute of Metals, the Iron and Steel Institution of Petroleum Technologists, the Institute ciety. It is proposed that all these societies should be housed under one roof and their libraries pooled for the common use of their members. As Sir Arnold pointed out, the scheme has the advantage that each society would retain its own individuality while giving its members facilities for informal meeting with members of related societies. It would thus be an important step towards the cooperation and coordination so necessary to-day in allied branches of science and technology. It was stated that £100,000 has already been promised in furtherance of the scheme.

DISCUSSION

OUR CONTEMPORARY RESEARCH "ACES"

Clinical medicine is justly proud of the four typical biologists mentioned in Dr. E. E. Free's recently published list[1] of the ten living scientists, whose removal at the present time would be "an irreparable loss" to future clinical science. Without questioning the limitations and bias that led this retired agricultural chemist to select these particular four experimenters from the scores of equally skilled contemporary scientists, whose published results are in many cases too technical for a non-clinical agriculturist to understand, one can still raise the question if his selected four, or any dozen scientists similarly selected, are in reality "irreplaceable." What effect would it have on medical progress if Dr. Free's hand-picked research "aces" were to-morrow "sunk without trace" in our historical archives?

It is, of course, a picturesque hypothesis of the lay mind that medical progress is due solely to the half dozen specially gifted individuals of each generation whose initiative and exceptional mentality make them the pace-makers of clinical evolution. Conventional history is rich in such alleged research giants, varying from the mythical therapeutic demigods of ancient Greece to the almost equally apochryphal Listers, Pasteurs, Oslers and Ehrlichs of recent decades. To the lay mind, the premature removal of any one of these semi-deified medical "wizards" would have retarded clinical evolution for untold centuries.

This picturesque hypothesis of the sporadic personal factor in medical evolution is, of course, not endorsed by competent sociologists who have made a real effort to determine the underlying factor in clinical progress. One of the most convincing studies of this evolutionary mechanism is Professor Stern's recent volume,[2] "Social Factors in Medical Progress," published under the auspices of the faculty of political science, Columbia University. Professor Stern cites historical evidence that so-called gifted individuals were not important factors in our historic medical development, and frankly contends that the same progress would have been made on the removal of any or all of the ancient popularly recognized research heroes.

Professor Stern's most convincing argument that important clinical inventions and discoveries are determined solely by the general rise in cultural level in a dozen collateral fields of non-clinical science is based on the simultaneous, independent, multiple discoveries, and inventions in all fields of practical medicine. He cites hundreds of such research duplicates, ranging from the ten practically simultaneous inventions of the laryngoscope to the five independent discoveries of adrenalin.

Eight simultaneous discoveries of the cellular basis of plant and animal life. At least three independent demonstrations of artificial immunity following inoculation with attenuated cultures of anthrax bacillus. Five officially recorded demonstrations of the clinical value of cowpox vaccinations, before Court Physician Jenner hogged the limelight. Five independent discoveries of the phenomenon of heartblock. Three simultaneous demonstrations of vasco-constrictor nerves. Five independent introductions of ether as a surgical anesthetic.

The ophthalmoscope simultaneously invented in Germany and England. Agglutination of typhoid bacilli independently discovered in England and France. The cause of amebic dysentery independently determined in Austria, Russia, Egypt, and the United States. Coexistence of cardiac hypertrophy and kidney lesions simultaneously observed in England, France and Germany. Sphygmomanometer independently invented in Italy and England, and ten years later, simultaneously improved in Germany and France. The chemical nature of respiration simultaneously worked out in Holland, Sweden, Italy, and France. The hypodermic syringe independently invented in Ireland, France and Scotland.

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[1] E. E. Free, "Who Are the Greatest in Science," *North American Review*, January, 1930.

[2] B. J. Stern, "Social Factors in Medical Progress," Columbia University Press, 1927.

If Dr. Stern's thesis is correct, the premature removal of Jenner would not have retarded the development of cowpox inoculation by a single year. It merely would have shifted the focus of popular reward to Schleswig-Holstein. Pasteur's removal would not have retarded the development of applied bacteriology, but would have shifted the central figure of national propaganda to Germany. Or to Enland. Lister's premature death would have deified his American contemporary, Guerini, the at present unknown though no less real father of aseptic surgery, without retarding in the least the historic development of modern surgical technique.

Popular reward of medical research plays some queer tricks with historic medical perspective. Richet, semi-deified with the Nobel prize for his duplication of Rosenau and Anderson's rediscovery of what was at the time referred to in European laboratories as the "Theobald Smith phenomenon," for which, ten years earlier, Theobald Smith had claimed no priority, since he knew that the same phenomenon had been fully described as early as 1838 by physiologists whose names are at present unknown to the newspaper public. Banting, honored for his confirmation and popularization of the work of a Chicago physiologist, at present unknown to reportorial fame, who ten years previously[3] had prepared and tested insulin, for which work this physiologist claimed no personal credit, knowing that it was but a logical application of the pioneer researches of a half dozen unexploited Allens and Opies. d'Herelle glorified for his picturesque nomenclature ("bacteriophage") with which he confirmed and popularized the well-known transmissible bacterial lysin of Twort. Widal immortalized in the "Widal reaction" for his service in popularizing Gruber's confirmation of Gruenbaum's discovery of a reliable diagnostic test for typhoid fever.

All honor to Dr. Free's hand-picked research "aces." Long may they wave. And equal honor to the scores of unexploited contemporary medical scientists, whose publications are too technical for Dr. Free's non-clinical appreciation. But clinical medicine may well congratulate itself that it is not dependent upon these alleged sporadic geniuses, but upon the more real though less picturesque cultural urge of ten thousand collateral scientists, an evolutionary force dwarfing the allegorical research demigods of conventional history.

W. H. MANWARING

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[3] *J. A. M. A.*, 1923, *81*, 1303.

σ

RECENT discussion in SCIENCE seems to make it quite clear that $m\mu$, and not $\mu\mu$, is the proper symbol for the millimicron, that the micron, μ, is properly conceived as a micrometer, and that the small Greek letter in general stands for the millionth part of the standard unit.[1] Thus I am informed that γ is used for the microgram and λ for the microliter.[2] This standardized usage raises an interesting question about the proper symbol for the millisecond (0.001 sec.). Psychologists and physiologists, at least, use σ for the millisecond.

This use of σ for the millisecond was explicitly introduced by Cattell in 1885 on the mistaken analogy that a thousandth of a second should have a symbol analogous to μ, which he then thought of (as have so many others since) as meaning a thousandth of a millimeter rather than a millionth of a meter.[3] Wundt adopted the symbol σ at once, giving it the weight of his authority at the time when reaction-times, expressed in milliseconds, were a very important topic in psychology.[4] I do not know how or when physiologists came to adopt the symbol.

Recently the matter has been complicated further by the necessity of psychologists for dealing with the microsecond in work on the localization of sound. Here the original error has been multiplied by the use of $\sigma\sigma$ for the microsecond.[5]

There is no simple solution of the difficulty. The usual symbol for the second is "sec.," but there is some authority for using "s." Logically then one might write ms. (not σ) for the millisecond, and σ (not $\sigma\sigma$) for the microsecond.

A very different ambiguity arises because σ has come to be used in statistical work for the standard deviation. So far as I can discover, this use of the symbol was initiated by Pearson in 1894.[6] It was not used by Galton or Edgeworth. Ordinarily no confusion arises from the double meaning, but sometimes, as when the standard deviations of reaction-times are under consideration, there may be very real difficulty. Cattell seems to have antedated Pearson by nine years, but of course Wundt's and Galton's schools did fuse until comparatively recently.

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[1] See the clarifying note by N. E. Dorsey, SCIENCE, n.s., 71, 1930, 67f., and the earlier discussion there cited.

[2] By Dr. G. K. Burgess, of the Bureau of Standards, and by Dr. Dorsey, who cites numerous references.

[3] J. McK. Cattell, *Philos. Stud.*, 3, 1885, 102: "My proposal that $\sigma = 0.001''$ is made on the analogy to the commonly used symbol $\mu = 0.001$ mm." *Cf.* also, Cattell, *ibid.*, 3, 1886, 306.

[4] W. Wundt, "Physiologische Psychologie," 1887, II, 267.

[5] E. M. von Hornbostel and M. Wertheimer, *Sitzungsber. d. preuss. Akad. d. Wiss.*, 1920, 338. I must plead guilty to having been one of those who have helped in publication to establish this faulty symbol.

There is no proposal for reform that I wish to make, unless it be that the word *millisecond* might be used more and the symbol σ less. I can not help wondering what others think about this matter.

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PEDOGRAPHY

IT is obvious that the students of soil science are not agreed on the term they will use for their division of natural science. There has been a trend toward the word *pedology*, but in some circles there is a protest because the term is now being used by a limited section of the medical profession.[1] It has been pointed out that *paedology* or *paidology* is the word which should be used by the medical profession.[2] The pronunciation of the two will be essentially the same, but this need not cause confusion. Furthermore, Brown[3] has pointed out that pedology was first used by the Russian soil scientists in 1865.

The term pedology has been presented to a larger audience than the students of soil science by the publication of Wolfanger's little book called, "The Major Soil Divisions of the United States."[4] He uses not only pedology, but several other words having the same root. These terms are: pedologist, pedologic, pedological, pedalfer, pedalferic, pedocal and pedocalic. The subtitle of his book is "A Pedologic-Geographic Survey." Since he has placed considerable emphasis upon the distribution of the soils, it is suggested that *pedography* be added to the list, and that the term shall have as its connotation the geographic aspects of soil science. How simple the title of Wolfanger's book would have been as "The Pedography of the United States"!

Geographers are frequently on the receiving end of jibes from the followers of the so-called pure or natural sciences, who imply that they are not contributors but borrowers. Whether or not this criticism is justifiable I will not debate, but assuming that there is a borrowing, it becomes imperative that the students of soils come to some agreement as to what they will call their division of science, for the geographers will borrow, and the success of the borrowing depends in a large measure upon the progress of pedology. In defense of the borrowers it is necessary to insist that the material selected should have some habitat significance. The student of modern geography is not qualified to undertake a regional analysis unless he has a rather systematic knowledge of the physical environment, and certainly soil is an important element in most parts of the world. Huntington and Carlson's "Environmental Basis of Social Geography"[5] is one of the first text-books of geography to treat soils according to the attributive system.

Geographers are generally agreed that climate is the most important element of the physical environment. The science of climatology is an important part of the training of a geographer if he is to understand the environment. The geographical distribution of climates or climatic types is of major importance, and here and there in the literature of geography and climatology appears the term *climatography* which connotes regional or geographical climatology.

If climatography is appropriate for that division of climatology which treats of regional climate, so pedography may be used for that division of pedology which treats the geographical distribution of soils.

The purists may insist that pedography should connote simply a description of soils, but geography is not a descriptive science simply. Just as geography, as an exact or social science, has become interpretative, so pedography may be considered as that division of soil science that treats of the regional distribution of soils. Pedology, then, may be concerned chiefly with the vertical attributes of soil types, and pedography with their distribution and delineation.

GUY-HAROLD SMITH

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OVERHEAD

RECENTLY I wrote a paper on the carpenter bees of the Philippine Islands and sent it to the Philippine Bureau of Science for publication. It was typewritten in Manila, and on November 21 Mr. R. C. McGregor sent me the typed copy for verification before printing. The package reached me on January 10 through the War Department, postmarked Washington, D. C. The letter accompanying it was endorsed as follows:

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[6] K. Pearson, *Philos. Trans.*, 185A, 1894, 80. Dr. T. L. Kelley writes me that Dr. H. M. Walker also finds this place to be the first use of σ for the standard deviation.

[1] See W. A. Hamor's note in SCIENCE, 71: 70, January 17, 1930.

[2] See P. E. Brown's note in SCIENCE, 71: 243, February 28, 1930.

[3] *Ibid.*

[4] Published by John Wiley and Sons, Inc., New York, 1930.

[5] Published by Prentice-Hall, Inc., New York, 1929.

(1) November 26, Department of Agriculture and Natural Resources.

(2) November 27, Department of Agriculture and Natural Resources. Respectfully forwarded to the Secretary to the Governor-General, requesting transmittal.

(3) December 4, Office of the Governor-General of the Philippine Islands. To the Chief, Bureau of Insular Affairs, War Department, Washington, D. C.

(4) January 6, War Department, Bureau of Insular Affairs, Washington, D. C. Respectfully transmitted.

Considering all this, the package came through fairly promptly, and I do not suggest that these various offices, organized as they are, are not efficient. I do suggest, however, that all this overhead is senseless and wasteful, and foreign to the spirit which I have come to regard as characteristic of this country.

T. D. A. Cockerell

University of Colorado,
January 10, 1930

QUOTATIONS

THE NEW PLANET

At a meeting of the Royal Astronomical Society on March 14 the report from the Lowell Observatory of the discovery of a new planet was discussed.

The following summary is given in the London *Times:*

Dr. A. C. D. Crommelin, who presided at the meeting, said the occasions when a new major planet was added to the members of the solar system were exceedingly rare and very important. Apart from the "small vermin of the heavens," as the minor planets had been called, there had been only two cases of discovery of new primary bodies in the system—those of Uranus and Neptune. Thursday was the one hundred and forty-ninth anniversary of the discovery of Uranus by Sir William Herschell and that anniversary was marked in a very appropriate way by news of the discovery of another planet.

The telegram, which had been received by the society from America, through the Bureau of the International Astronomical Union at Copenhagen, was as follows (explanatory words interpolated in square brackets):

> Lowell Observatory search for trans-Neptunian planet revealed an object of fifteenth magnitude, for seven weeks in rate of motion and path conforming to approximate distance [the late Professor Percival] Lowell assigned. [The position on] March 12 3h. 7 time-seconds west [of] delta Geminorum, agreeing with Lowell's longitude.—Shapley.

The society's foreign secretary had prepared the following telegram, which had been approved by the council:

> President, council and fellows of the Royal Astronomical Society, in meeting assembled, send the Lowell Observatory their heartiest congratulations on the great discovery of the trans-Neptunian planet.—Turner, *foreign secretary.*

Those whose memories extended back over half a century would remember the efforts made both on theoretical and observational lines to find the trans-Neptunian. On the theoretical side a lot of time and great care had been spent in determining the position of a body that would account for the small residuals in the motion of Uranus. Neptune was not used much because it had not been observed long enough to get an exact mean orbit. Lowell thought there were two possible positions, 180° apart, either of which would account for the small residuals he found. The latter of the two, which he probably looked upon as the least likely, now proved to be the one which agreed with the present position. All observers had had great faith in Lowell's prediction, and those at his observatory had spent a long time observing the new planet without saying anything about it. They had been taking photographs along the ecliptic, showing very faint stars, and studying them for changes of position. At last, in the middle of January, they found a body moving slowly in the constellation Gemini. They followed it for seven weeks, and now they had got an orbit sufficient to show that it was outside Neptune and within Lowell's orbit.

Such a planet had been conjectured to exist by a good many people besides Lowell. The study of comet orbits had led to the conjecture of a planet with a period of about three centuries. Another telegram gave an estimate of the size of the body. It was said to be of the fifteenth magnitude and intermediate between that of the earth and Uranus. The exact mean of the two would give a diameter of 19,000 miles, but it was too small for its dimensions to be measured with any accuracy. There was a hope that images of the planet might be found on past photographs. When once the approximate orbit of this body was made out there was very good hope that on the Franklin Adams chart and on the photographs taken at Heidelberg and elsewhere when searching for minor planets this planet would be found.

Professor H. H. Turner, director of Oxford University Observatory, said it was hard that Professor Lowell should have died before verification of the discovery which he felt sure would come had been obtained. His confidence was shown in the fact that he left a legacy for the observatory which he founded to continue the search he had instigated and formulated. It was specially pleasing to find that the discovered planet came out so close to the prediction he made. The honor of the prediction must be shared to some extent with their old friend Professor W. H. Pickering, who, when he was working for Harvard in 1919, made a prediction which was very near to the place.

Dr. J. Jackson, chief assistant at the Royal Observatory, said that, at a rough calculation, the planet in seven weeks should have moved something like half a degree in its geocentric orbit. Now it should move about 30 seconds a day. It was now in the position 7 hours 15 minutes. Lowell's figures for 1914 placed it in longitude 84. That was deduced entirely from the perturbation of Uranus. On that basis its predicted position to-day would be longitude 100; actually it had been found on longitude 107. Lowell's work was worthy of considerable attention. He thought the discovery would explain a good deal of the perturbation of the planets.

Professor A. S. Eddington, of Cambridge, remarking on the closeness of the prediction, said that if one had had faith and had given a long exposure with a reasonably large lens, the planet must have been picked up. Many of them had been much impressed with the thoroughness, caution and honest work at Lowell Observatory.

Captain Ainslie, president of the British Astronomical Association, asked if the planet had been seen or only photographed.

The chairman said that as the size was given he assumed it had been seen visually.

Professor Turner thought this might rather be a calculation from its brightness.

Dr. Jackson said they were going to make a search of the Franklin Adams plates at Greenwich, but if the planet were there it would be very near the edges of the plates.

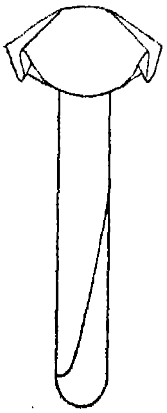
Summing up, the chairman said this planet would probably have an effect on Halley's Comet that would alter the period of each return by as much as a couple of days, so that some of the unaccounted for days in the last two returns might meet with an explanation. In the course of time, when they had got a good enough orbit, it would involve the preparing of new tables of Uranus and Neptune. In the case of Neptune, the mass was very quickly got by the discovery of a satellite; there was very little chance of discovering a satellite of this body, and the only way to get its mass would be by getting the perturbations of Uranus and Neptune, and that would only give a rough result. Finally, every book of descriptive astronomy from that day was out of date.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A CONVENIENT METHOD OF REDUCING DESICCATION IN SLANT CULTURES

It is often desirable to reduce desiccation in slant cultures of fungi or bacteria, or in tubed media. The time-honored method of sealing cultures by dipping the stoppered end of the tube in paraffin presents some unsatisfactory features. When cotton stoppers are permeated with the wax they are difficult to remove and somewhat unwieldy. When replaced they do not fit tightly, and are not then proof against contamination. When the cotton is filled with wax the exchange of gases through the stoppers may be so reduced as to limit the growth of the culture, or alter the appearance of the organism.

Folding a piece of tinfoil over the mouth of culture tubes is a convenient means of reducing desiccation and has the advantage that the tubes of culture media may be sterilized after the foil caps are in place. Since vapor may readily escape between the foil cap and outer wall of the culture tube a greater reduction in the rate of desiccation is often desirable. In this paper is described a method of reducing desiccation in slant cultures that seems to possess certain advantages.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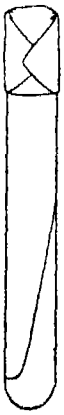
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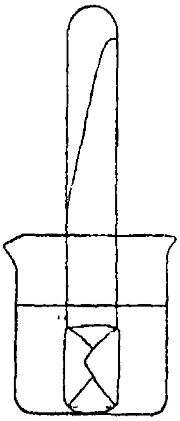
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Paper disks of a convenient size for folding over the end of culture tubes are cut from thin, tough and pliable paper. These disks are stacked up and submerged in melted paraffin just deep enough to cover them. After the papers are thoroughly saturated with the wax they are lifted out of it one at a time with needles or fine-pointed tweezers. They are held vertically for a few seconds to allow the excess of wax to drain off and are then dropped into cold water. The wax should be kept hot enough to allow the excess to drain from the paper before solidification occurs. The waxed paper disks may be used as soon as they are removed from the water or may be stored until needed.

Before a tube is sealed the open end is warmed slightly and the end of the cotton stopper is singed. A waxed paper disk is warmed until the wax becomes plastic, a condition that is obtained just before the melting-point is reached. It is then folded over the end of the tube (Fig. 1) and pressed firmly against the outer wall, and the folded edges are pressed down firmly. This procedure gives a waxed paper cap (Fig. 2) that permits an exchange of gases along the line of the folds, reduces the desiccation materially and keeps the cotton stoppers free from wax. The caps may be removed by giving them a firm twist or by unfolding the paper. When a perfect seal is desired, the tubes are inverted and dipped one or more times into paraffin, to a point just above the waxed paper cap (Fig. 3). For this purpose the temperature of the wax should be but slightly above its melting-point.

This method of reducing desiccation in slant cultures and in tubed media, as used for several years by the writer, has been uniformly successful. The method is very useful when a long period of incubation is required. Cultures can be kept in a suitable condition for study for several weeks, and, by completely sealing, sterile tubed media may be kept ready for use during a long period.

The method has a decided disadvantage. When the tubes are sealed the cotton stoppers are kept moist by water of condensation, permitting fungi to grow through them and contaminate the cultures. Contamination in this way is almost entirely avoided, however, when the work of preparing the waxed paper disks, the storing of them and the sealing of the tubes is done under aseptic conditions.

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A METHOD FOR DETECTING ACID-FAST BACTERIA IN THE SOIL

It has been assumed that saprophytic acid-fast bacteria are rather wide spread in nature and that their appearance in soil is not an uncommon occurrence. There has been, however, no definite evidence to substantiate this assumption.

In view of these facts experiments have been under way for several months attempting to identify these organisms under various natural conditions and more especially in the soil.

The technique used is as follows. Soil samples in approximately one gram portions are mixed with about 50 to 60 cc of modified Büttner's[1] medium in 200-cc flasks. This medium which has previously been sterilized in the flasks has the following composition:

Tap water	1000 cc
K_2HPO_4	0.5 gm
NH_4Cl	0.5 gm
$Mg\,SO_4$	0.2 gm
$CaCO_3$	0.2 gm

It will be noticed that this medium contains no available carbon. To supply this carbon, paraffin-coated pebbles are placed in the flasks. These pebbles are large enough so that they will extend above the surface of the medium. Supplying carbon in this way seems to be quite effective in keeping down contamination since a great many organisms can not thrive under these conditions.

Incubation is carried out at 47.5° C. It was found that at lower temperature there were gross contaminations by molds so that the acid-fast bacteria were so completely covered as to render detection of the organism very difficult and their isolation virtually impossible. When the high temperature was used there was no evidence of contamination by molds.

Up to the present time this technique has been applied to some thirty soil samples, and acid-fast bacteria have been found in every instance after from two to seven days' incubation.

In the incubation process some of the paraffin melts from the coated pebble and forms a thin pellicle on the fluid. The organisms are found on the under side of this pellicle and on the paraffined surface of the pebble. They can also be found, in many cases, adhering to the sides of the flask just above the surface of the medium. Under this latter condition we frequently get large masses of the organism which are comparatively free from contamination. After prolonged incubation it is usually possible to detect masses of the organisms with the naked eye. These have the appearance of opaque bodies on the surface layer of paraffin, on the pebble or on the side of the flask. In chromogenic species the color can be detected in these areas.

The organisms when isolated show numerous variations both morphologically and culturally. A discussion of these variations does not seem necessary at this time. When the organisms are stained with hot carbol fuchsin all are highly resistant to decolorization by 3 per cent. HCl in 95 per cent. alcohol.

A number of these organisms have been isolated by making dilution plates using Conn's[2] medium to which is added gentian violet in a dilution of 1 to 10,000. The composition of this medium is as follows:

Water	1000 cc
Agar	15 gm
Glycerin	10 gm
K_2HPO_4	1 gm
Sodium Asparaginate	1 gm

While the number of soil samples examined is rather small, the writer feels that the method described is a relatively simple way of detecting these organisms in soil. The collecting of samples from various parts of the United States is now under way, and these will be subjected to this technique. A more detailed account of this problem will appear at a later date.

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[1] Hans Büttner, "Zur Kenntnis der Mykobakterien insbesondere ihres quantitativen Stoffwechsels auf Paraffinnährboden," *Arch. f. Hyg.*, 97: 12, 1926.

[2] H. J. Conn, "The Use of Various Culture Media in Characterizing Actinomycetes," N. Y. Ag. Exp. Sta. Tech. Bul. 83, April, 1921.

SPECIAL ARTICLES

SUSCEPTIBILITY OF WHITE MICE TO THE VIRUS OF YELLOW FEVER[1]

It has been found that if yellow fever virus is injected into the brains of white mice, a certain number become ill and die. The virus can be propagated in mice indefinitely by the intracerebral injection into normal mice of the brain of an infected mouse. Once established in mice the passage virus invariably produces death after an intracerebral injection. In the early passages death usually took place on the seventh or eighth day. In subsequent passages there was a gradual shortening of the incubation period, so that by the sixtieth passage death occurred on the fifth day.

The virus is highly neurotropic in mice. Infection can be produced by the injection of the virus into the brain, spinal cord or eye. Other routes of injection, such as intraperitoneal, subcutaneous, etc., very seldom cause illness and death, though a considerable proportion of such mice are rendered immune to a subsequent intracerebral injection of the passage virus.

At death the virus can be demonstrated to be present in large amounts in the brain, spinal cord, peripheral nerves and the adrenal glands. The blood, liver, spleen, kidney and testis contain very little if any virus.

Continuous passage of the virus through mice leads to a gradual loss of virulence for rhesus monkeys. Monkeys were injected with the third, twenty-ninth and forty-second passages in the mice. The animal injected with the third generation died of typical yellow fever on the fifth day. The monkey which received mouse virus from the twenty-ninth generation developed a febrile reaction on the sixth and seventh days and recovered. This monkey was subsequently shown to be immune to virulent yellow fever virus derived from another monkey. The third monkey was injected with the forty-second generation of mouse virus and remained well. It was found dead on the forty-eighth day, death being due to some intercurrent disease.

The mouse virus can be preserved in 50 per cent. glycerine, at 2°–4° C., for at least fifty-eight days but not for one hundred days. Infective brain kept in a frozen condition at – 8° C. retains its virulence for at least one hundred sixty days.

The mouse virus is neutralized by immune yellow fever serum derived from monkey or man. This effect can be shown by mixing infective mouse brain with the serum to be tested and injecting the mixture intracerebrally into normal mice. Normal serum has no protective action.

There are very few macroscopic changes in mice dying of an infection with yellow fever virus. Hemorrhage into the stomach, in about 50 per cent. of the mice, is the only abnormal finding sufficiently common to warrant the conclusion that it is caused by the virus.

Microscopical examination of the brain shows in the early stages a definite proliferation of the endothelium of the capillaries with an accumulation of mononuclear cells in the perivascular spaces, while in the late stages the picture is distinctly reminiscent of encephalitis lethargica. The ganglion cells undergo necrosis and there are invariably present eosinophilic nuclear changes resembling those present in the liver of man and monkey dead of yellow fever and described as inclusions by Torres[2] and Cowdry.[3]

The neurotropic character of yellow fever virus in mice and the nature of the pathological lesions produced are factors giving strong support to the theory that the infectious agent of yellow fever should be classified with the filtrable viruses.

In relation to these experiments it is of some interest to add that Dr. A. W. Sellards informs me that Dr. Laigret in the study of yellow fever patients in Senegal noted in exceptional cases minor neurological symptoms and suggested the importance of testing the central nervous system for the presence of virus and to observe the effect of inoculating the virus into the central nervous system.

A detailed account of which the above is a summary is in preparation and will be published in the near future.

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AN INTERPRETATION OF MASS CONJUGATION IN PARAMECIUM

When freshly gathered material for the study of Paramecium is assembled at the spring of the year shortly after the great thaw in this latitude, it may be observed after a few days that a strong tendency to conjugation manifests itself in the wild culture. Under these conditions the presence of one hundred to

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[1] The monkeys used in these experiments were supplied by a grant from the DeLamar Mobile Research Fund.

[2] C. M. Torres, Supplemento das Memorias Instituto Oswaldo Cruz, 1929, No. 6.

[3] E. V. Cowdry and S. F. Kitchen, Science, 69: 252, 1929.

upwards of three hundred couples in a single slide culture may be regarded as an indication of maximum conjugation. This has been observed in the spring of 1926 and again in the autumn of 1929, the greater number being recorded in the spring. The occurrence of so many conjugants precisely at the turning-points of the year suggested a reference to climatic conditions. The spring and autumn maxima occur at what Chatton[1] has called periods of crisis characterized by trophic disequilibrium. It is indeed enough to witness the decline of aquatic vegetation in late autumn in order to convince one of the fact that the nutritive conditions in the water are undergoing rapid change at that season, and the well-known sensitiveness of Paramecium to change of temperature points in the same direction. If a slide culture is placed for a few minutes between double windows in freezing weather, all movement ceases until they are restored to the warm room; if exposed too long to the cold, they die without encysting. No experimental means have yet been discovered to make Paramecium encyst, and it is sometimes stated positively that Paramecium never becomes encysted (Perrier).[2] Métalnikov[3] established the fact, from laboratory cultures in Russia, that the mean daily fission rate was greater in summer than in winter; and in 1915, when owing to defective heating the room temperature fell below normal, the number of annual generations dropped from about four hundred to two hundred and thirty-eight.

Treatment of laboratory cultures at room temperature with distilled water will also induce mass conjugation. We have observed this effect in the month of February, this year, both in subcultures and in renewed cultures. In watchglasses containing a small quantity of freshly matured and diluted hay infusion, seeded with a few individuals from the main culture, after two days of preliminary multiplication the addition of a few drops of distilled water brought about a large proportion of conjugants within the next twenty-four hours. H. S. Hopkins[4] found that the addition of certain salts to his renewed cultures made them more susceptible to conjugation after a preliminary period of multiplication lasting from three to five days.

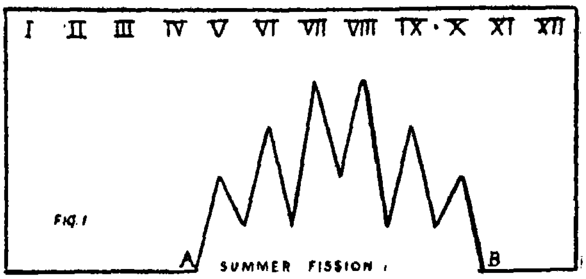

FIG. 1

From the various observations which we have made from first to last and in general accordance with the known reactions of Paramecium, we feel that there is sufficient foundation for plotting a tentative growth curve representing the annual cycle of Paramecium under natural conditions in the climate of Montreal. Experiments on Paramecium have yielded results of the highest importance since the classical researches of Maupas, but it seemed worth while to make the attempt to frame a picture of the probable course of events in the open waters, especially under a climate where the seasonal changes are sharply accentuated and consequently where such questions can best be put to the test. The point marked "A" in the chart stands for the turn of spring; the point "B" marks the autumn transition. At both these seasons, as mentioned, mass conjugation has been found to take place, suggesting a twofold significance for it: first, that of activating fission for the summer; secondly, that of stiffening resistance for the winter. The apparent simplicity of the annual cycle, commencing with the vernal conjugation, passing through the summer fission to the autumn climax and ending in the winter rest, is perhaps an argument for its probable approximation to the truth. The spring maximum may be compared with the formation of reproductive cysts in other Infusoria, and the autumn maximum is paralleled by the resting cysts.

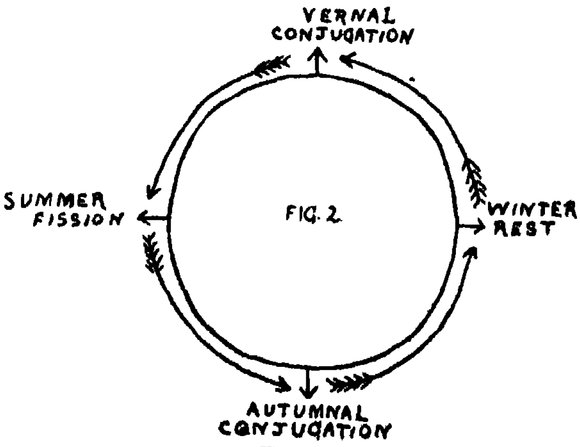

FIG. 2

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[1] E. Chatton et Mme. M. Chatton, "La sexualité provoquée expérimentalement chez un Infusoire: *Glaucoma scintillans*. Prédominance des conditions du milieu dans son déterminisme," *Comp. Rend. Acad. Paris*, 176: 1091–1093, 1923.

[2] E. Perrier, "Traité de Zoologie," fasc. II, p. 503. Paris (Masson) 1897.

[3] S. Métalnikov, "Immortalité et rajeunissement dans la biologie moderne." Paris (Flammarion), 1924.

[4] H. S. Hopkins, "The Conditions for Conjugation in Diverse Races of Paramecium," *J. Exp. Zool.*, 34: 339–384, 1921.

A prominent feature of mass conjugation is its simultaneity, comparable in this respect with the simultaneous cleavage of embryonic cells. At the annual changes from winter to spring and from summer to autumn, the Paramecium population responds *en masse* to the exigencies of the times. The normal summer fission rate is likewise fairly uniform in its incidence, so that the multiplication of an actively feeding community is essentially a synchronous reaction of large numbers of individuals to alterations in the internal medium or endoplasm, while the so-called epidemics of conjugation are mass demonstrations following upon alterations in the external medium. Conjugation, which can be induced experimentally in a mixed culture without the addition of salts, thus appears to result from the interaction or concurrence of two sets of factors, external and internal, not one to the exclusion of the other; and under natural conditions, the seasonal changes are enough to provoke similar responses.

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C. LHÉRISSON

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IS THERE A NEUROMOTOR APPARATUS IN DIPLODINIUM ECAUDATUM?

DURING the course of recent investigations on a hitherto undescribed ciliate occurring in the cecum of cattle, the writer made comparisons with *Balantidium coli* from the pig. The centralized neuromotor apparatus described and figured by McDonald[1] in the latter protozoan could not be differentiated. In order to check the staining reactions *Diplodinium ecaudatum* was studied, because Sharp's[2] excellent description and figures give the impression that the neuromotor apparatus of the latter ciliate is easily demonstrated. According to this author a mass of material which occurs just above the base of the left skeletal area and between the left extremities of the dorsal and the adoral membranelle zones has the staining reactions of amphibian nervous tissue. Fibers run out from this body to all the motor membranelles, to the membranelles for food taking and also to the esophagus, forming a ring around the latter from which branches extend longitudinally. The reasons which are stated for assigning a neuromotor function to the above structure are: (1) Its general similarity to primitive metazoan nervous systems; (2) its position within the body, not being connected to adjacent structures; (3) its freedom from attachments and other characteristics that are required for an organelle of contraction or support, and (4) its connection by nerve-like strands to all mobile territory. The writer was greatly surprised to find the relationships of this area not as Sharp described them and therefore questions his interpretation.

METHODS OF INVESTIGATION

A method was devised of orienting Protozoa in the paraffin so that complete serial sections could be made either transversely or longitudinally through isolated individuals. This method is described in another publication (1930). One especially good series contains fifty-four cross-sections cut at three microns and another series contains forty-two longitudinal sections of the same thickness, though usually there were about twenty-five to thirty longitudinal sections. It is much easier to trace tissues and layers in series thus prepared than in sections through masses of Protozoa which have been imbedded in gelatin capsules, because the observer knows definitely the orientation of a particular organism and is not confused by adjacent sections of other individuals. The technique described by Sharp of differentiating with Mallory's triple connective tissue stain and with iron hematoxylin was followed.

POINTS OF DIFFERENCE FROM SHARP'S INTERPRETATION

On the whole, the correctness of the accurate, painstaking description by Sharp of the arrangement and anatomy of the various organelles and tissues was fully confirmed. However, there occurred in my material organisms that are very closely allied to Diplodinium which were not mentioned by Sharp and were described and figured, though very inaccurately, by S. Awerinzew and Mutafowa.[3] To include these forms the above authors founded the genus Metadinium. Other very closely allied ciliates which Crawley[4] included in the genus Epidium were not noted either by Sharp or by myself. In my studies, the layer of ectoplasm lying directly under the pellicle was not observed to be alveolar. It stained very deeply and persistently with iron hematoxylin and appeared to be of very compact material. Directly under this layer was another layer which is described by Sharp as alveolar, but which in my material exhibited the same staining reactions as the inner boundary layer of the ectoplasm. This layer could be followed into the folds that comprise the various outer and inner lips and furrows at the anterior end of the body. It is also thicker here than in the posterior end of the body. In a number of places it is reflected back upon itself for considerable distances especially in the area where Sharp describes the motorium. In fact, in the thin and well-destained sections a fold of this layer resembled in size, shape and position the motorium figured by Sharp, and no other tissue could be differentiated which could be made to answer for this body. Sharp's drawings are all semidiagrammatic, made by superimposing camera lucida sketches of several sections. It is, therefore, difficult to compare them with sections on slides. From my point of view his microphotographs of hematoxylin preparations indicate that his slides were not sufficiently destained. For example, his Fig. 15, plate 6, shows in addition to the motorium another mass equally dense on the ventral side of the cytostome and still another in the dorsal membranelle zone. This author states that the inner boundary layer of the ectoplasm stains very deeply. The writer has noted repeatedly that in sections of three microns the hematoxylin stain disappears from this layer after treatment for from three to five minutes with 2 per cent. iron alum, whereas the nuclei, the pellicle with its underlying ectoplasmic layer, the myonemes and the basal granules of the cilia remain black or bluish black for nearly an hour. The mass which appears to correspond to the motorium is completely destained in all my hematoxylin preparations, though, as Sharp reported, it usually retains the acid fuchsin of Mallory's stain as does also the inner boundary layer of the ectoplasm and the micronucleus. On the basis of my interpretation the motorium is a fold of an ectoplasmic layer which forms a cylinder surrounding the esophagus and also underlies the ciliary rootlets of the membranelles because it extends into all the lips and furrows at the anterior end of the body. It is obvious that sections through this layer would appear as strands. The conditions set forth by Sharp for a coordinating nervous mechanism do not, therefore, appear to be fulfilled in the structure that the writer finds in this ciliate.

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[1] James Daley McDonald, "On *Balantidium coli* (Malmsten) and *Balantidium suis* (sp. nov.), with an Account of their Neuromotor Apparatus," Univ. Calif. Publications in Zool., Berkeley, v. 20 (10), May 8, pp. 243–300, figs. A-O, pls. 27–28, figs. 1–14. 1922.

[2] Robert G. Sharp, "*Diplodinium ecaudatum*, with an Account of its Neuromotor Apparatus," Univ. Calif. Publications in Zool., Berkeley, v. 13 (4), May 4, pp. 43–122, figs. A-D, pls. 3–7, figs. 1–33. 1914.

[3] S. Awerinzew and Mutafowa, "Material zur Kenntnis der Infusorien aus dem Magen der Wiederkäuer," *Arch. f. Protist.*, 33: 109, 1914.

[4] H. Crawley, "Evolution in the Ciliate Family Ophryoscolecidae," *Proc.* Acad. Nat. Sci. Phila., 75: 393, 1924.

Observations concerning the Diet of *Diplodinium ecaudatum*

According to Sharp this ciliate lives solely upon bacteria, but my observations indicate that it ingests much larger food particles. Individuals taken from a steer that had been feeding on green grass appeared to have eaten some of this material. One ca[illegible] cannibalism was noted. The smaller ingested ciliate was not crushed by passing through the esophagus of its captor; digestive processes had not at the time of fixation progressed sufficiently to interfere with the staining reactions. The wall of the esophagus of *Diplodinium* appears to be folded into longitudinally extending accordion-like pleats which permit marked distention. Sharp's figures indicate this folding but he makes no comment. It is difficult to conceive how the passage of the ingested ciliate through the esophagus of its captor could have occurred without breaking the esophageal ring as Sharp figures this structure.

Comment and Conclusions

My interest was directed to the observations herein reported by the fact that disruptions of certain intestinal ciliates in unfavorable environments occurred by an outflow of the endoplasm through the cytostome. The digestive systems of the Protozoa, unlike those of the Metazoa, are characterized by a break of the layers. The pellicle and ectoplasm which line the mouth and esophagus are broken through at the distal end of the latter organelle. What prevents under normal conditions the outflow of the fluid endoplasm? This question led to the development of the abovementioned method of sectioning individual Protozoa in the same way that embryos are sectioned. It is obvious also that the presence or absence of nervelike fibers will have a bearing on the answer to the question. The writer realizes fully the responsibility for the stand that is here maintained because Sharp's researches led the way to a number of successful investigations of neuromotor systems of various ciliates from widely separated groups.

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BOOKS RECEIVED

Hoel, Adolf. *Resultater Av De Norske Statsunderstøttede Spitsbergenekspeditioner.* Illustrated. Jacob Dybwad, Oslo.

Allen, Arthur A. *The Book of Bird Life.* Pp. xix + 426. 275 figures. Van Nostrand. $3.50.

Kober, George M. *Reminiscences.* Pp. xxv + 403. Illustrated. Georgetown University.

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EMERGENT EVOLUTION AND HYBRIDISM

By Dr. ROBERT K. NABOURS

KANSAS AGRICULTURAL EXPERIMENT STATION AND CARNEGIE INSTITUTION, DEPARTMENT GENETICS

THE essential supposition of emergence, or emergent evolution, appears to be that the product derived from the synthesis of any number of elements is often quantitatively and qualitatively supervenient over their mere sum, or resultant, and thus it becomes something chiefly novel, the important features of which may even be extraordinarily dissimilar from those of the elements and subgroups that entered into its composition. The laws relating to and governing the whole are therefore comparably as restricted and peculiar to it as the laws relating to and controlling the respective components are exclusive and limited to them, and those of the one may not be even adumbrative of the others.

It has been long recognized that familiarity with the attributes of elements does not confer the ability to prognosticate the qualities of the wholes resulting from their syntheses. The behavior of neither hydrogen nor oxygen gives the slightest suggestion of the properties of water. The possibilities of gunpowder may not be deduced by an examination of the properties of either charcoal, sulphur or saltpeter, or of a combination of any two of them. Carbon, hydrogen and oxygen, each examined with respect to its qualities, or any two together, afford no connotation of the characteristics of ethyl alcohol, if these elements be combined in the one way, or of the ether they make when there is another arrangement of them.

The behavior of molecules may not be ascertained through a knowledge of merely the properties of their separate constitutive atoms; the molecular compounds do not present attributes which by simple additions result in the properties of cells; many of the properties of individual animals and plants are vastly different from the sums of the properties of the respective cells of which they are composed, and the qualities and appurtenances of plant, animal and human societies are far from representing nothing but the sums or mosaics of the characteristics of their several individual and subgroup constituencies.

This "novelty of behavior" has been well defined and interestingly discussed by a number of writers, and variously named "heteropathic causation," "emergency," "creative synthesis," "emergent vitalism," "organicism," "holism" and "emergent evolution." The term *emergent evolution*, suggested by C. L. Morgan, has been adopted by W. M. Wheeler, whose recent book treats the subject with serviceable succinctness and lucidity. Several others, including Wundt, G. H. Parker, Spaulding, Alexander and Smuts, have approved and elaborated the proposition, in one way or another, and Jennings has waxed enthusiastic to the point of declaring that "the doctrine of emergent evolution is the Declaration of Independence for biological science."

It is not inferred from the writings reviewed, Smuts possibly excepted, that the entire problem of evolution has been or may possibly be solved through the application of the principles of emergence. However, if nothing more, the hypothesis suggests a somewhat novel and interesting means of viewing the phenomena of a considerable section of the universe, including protoplasm, mind, personality and societies.

In an editorial[1] H. H. Laughlin stated that "geneticists, including students of eugenics, are deeply concerned with the facts of emergent evolution," and he also extended the idea to cover the phenomena observed in connection with qualities which seem to emerge from complexes of characters in organisms and particularly in man. He further suggested that some mutations may be of this nature. So far as I have been able to ascertain, Dr. Laughlin, in these suggestions, was the first to recognize the apparently pertinent coincidence between the supposition of emergent evolution, as outlined, and the apprehension of hybridism, or hybridity, as elaborated by Darwin and earlier observers, and especially by G. H. Shull, East, Hayes, Jones, Riddle, Jeffrey, Lotsy, Peacock, Harrison and other recent writers.

The term hybridism, or hybridity, as commonly employed by scientific plant and animal breeders, appears to signify a heterogeneous (we now know not necessarily heterozygous) condition of an organism with respect to two or more genes responsible for characteristics of discernible discreteness, whether they are linked to the extent of allowing crossing over, are allelomorphs or are distributed among two or more linkage groups. All these conditions usually prevail, wherein an organism may be heterozygous for certain genes and homozygous for others, all in one linkage group or distributed among two or more pairs of chromosomes. In this way bisexual plants and animals are commonly, to a less or greater degree, compositely hybrid in respect to a few, or several, characteristics for each of which they may be homozygous, and they would thus constitute true-breeding hybrids. In addition, they are generally heterozygous for several, or many other, factors with respect to which, of course, they do not breed true.

There are probably also genes that do not manifest themselves in the form of discrete characteristics even when contained in homozygous doses, yet they may become apparent as hybrid emergents when two or more different ones are represented in organisms in double doses, respectively, or some single and others homozygous. It is altogether likely that certain transient, apparently non-Mendelizing variations, or even some that remain constant as if they were outright mutants, belong to some such category. Several genes which modify recognizable characteristics, but which, of themselves, do not become manifest, have been reported. It is unlikely that any characteristic is ever the manifestation of the actions merely of one, or even two genes, or factors; each discrete characteristic is generally, if not always, the supervenient emergent of the interactions of several, or many genes. There are also other possibilities for heterogeneity, or hybridity of traits in bisexually reproducing organisms.

Darwin appears to have been the first to observe that it was the bringing together of dissimilar germinal substances, rather than the mere act of crossing, which produced extra size and vigor in hybrid plants and animals. Following his lead and in the light of Mendel's discovery and utilizing the results of their own and other extensive experimentation, G. H. Shull, East, Hayes and Jones have defined in some detail the probably precise means by which the changes, including additional size and vigor, as well as negative qualities, are obtained through hybridization. The hybrid vigor and increased size, as well as other superveniences derived from the crossing of different strains of Indian corn were emergents, each in respect to its properties, quite distinct from, and more than (rarely less than), the mere sum of the properties of the respective long inbred varieties. Numerous critically experimental results which support this thesis have been described by the authors named and by investigators who utilized for experimental purposes other plants and also animals.

More than three thousand named varieties of dahlias of widely differing color combinations, size and form have been noted by Jones, who states that all have been derived through hybridization from very few elementary strains, with possibly a few mutants which occurred during the relatively short period of their development. It appears that most horticultural achievements have been attained by means of hybridization, either through man's intentional effort or by chance in nature. It is generally recognized that in all the higher and many lower forms of plants hybridization has performed a conspicuous part in the development of the limitless varieties found distributed among the almost infinite kinds of environment in which they live. Every important group, as cotton, wheat, corn, sorghum, all fruits, shrubs, trees, weeds, wild as well as cultivated flowers, and vegetables—all are well known to be largely and, in many cases, wholly of hybrid origin. In most of them the distinguishing characteristics of the contributive races have become largely dissembled by the respective hybrid emergences.

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[1] *Eug. News*, January, 1929.

Starting with Darwin again, although the matter greatly antecedes his time, hybridization among animals, both the wild and domesticated, and including man, has been considered of major consequence. There is a vast literature dealing with the complexly hybridized condition of such domesticated animals as the fowls, cattle, sheep, dogs, cats and swine; in fact, all are involved usually to a high degree of heterogeneity, with infinite and incalculable numbers and varieties of supervenient emergences and probably with profound consequences in respect to distribution, tolerance and survival.

Among wild animals, hybrids are usually in such composite profusion, and so little do their hybrid emergent properties and the attributes of their constitutive elements adumbrate each the other, that it becomes quite impossible casually to distinguish them. Adequate analyses are feasible only if the organisms carry sharply contrasting characteristics and lend themselves to being bred in comparatively large numbers and over considerable periods of time. Among the more intricately complex, particularly the larger, slower-breeding, domesticated animals and man, rapid and commensurate analyses seem to be as yet impracticable, perhaps more because of the long time and excessive expense involved than on account of their complicated genetical natures.

The most extensive, critically experimental hybridization project of all time has been that of T. H. Morgan, his immediate colleagues and other workers throughout the world, in which the fruit-fly (Drosophila) has been utilized. Following Bateson's analogy and considering the genes responsible for the various characteristics as elements, the methods employed and the results obtained are closely coincident with those in chemical resolution and synthesis. The four hundred, or so, mutant genes of the fruit-fly have been allocated in a system such that they may be used in breeding synthesis and analysis in the identical quantitative way in which the chemical elements are employed. Other projects of this nature, contributing evidence in support of this generalization, all in the field of hybridism, have employed as experimental materials corn, tobacco, jimson-weeds, evening primroses, grouse locusts, mice, rats, guinea-pigs, rabbits, birds, fowls and, to some extent, the larger domesticated mammals and man, and a number of other organisms.

The methods, results and possibilities of genetics (experiments in hybridity) may be further illustrated by referring to the grouse locusts (Tettigidae) with which I have worked for several years. This subfamily of the Orthoptera has extraordinarily striking and variable color patterns. In one species (*Paratettix texanus*) a few over twenty-five distinct, dominant, elementary patterns have been resolved in the breeding processes. Twenty-two are so closely linked as not to allow crossing over; one is rather loosely linked with these, and one each appears to be on two other pairs of chromosomes. However, even with this arrangement, a prodigious number, mounting into the hundreds, of color pattern combinations have been developed. Many of these hybrid emergent patterns are stable, when inbred, while others are relatively so. In another species (*Apotettix eurycephalus*), in which linkage is not so close, other hundreds of true-breeding as well as unstable composites may be and have been developed from the thirteen conspicuous, diagram-like, dominant, primary color patterns.

Reference to the colored plates of my publications, or better, a view of the specimens in nature and in the laboratory, reveals the extraordinary extent of variations in color complexes, all derived from comparatively few primary patterns. Before experimental resolution and synthesis had shown how few original, primary characteristics were involved in the production of these numerous color pattern composites, speculation regarding them had been rife. The dominant, elementary color patterns, as well as the hybrids of the grouse locusts, are peculiarly discrete and diagram-like. They ought to lend themselves, the one to decipher the others, perhaps better than the characteristics of almost any of the other organisms hitherto submitted to Mendelian experimentation; yet in only exceptional cases, without previous experience, would it be possible to predict, merely upon inspection, what a specified group of elements would make, or what had gone into the production of a given complex. Now, with experience, numerous composites, each a supervenient emergent as novel in its attributes as any of the several components, may be developed at will. If the mutants which certainly occur, though rarely in the grouse locusts, be included, the probability of increased numbers and variability of hybrid emergents would be proportionately enormously enhanced.

The work with the grouse locusts so far has been devoted mainly to syntheses and analyses of color patterns and combinations. However, it has also been determined that certain size, form and vigor properties, some negative and others positive, including the capability of reproducing parthenogenetically and to simulate death, are emergents of hybrid syntheses.

So, altogether, there have been employed a considerable number of color, form and vigor, primary characteristics, ranging from very brilliant to extremely dull, and from strongly vigorous to lethal, not to consider those too subtle to be easily recorded. All are readily capable of hybridizing in practically infinite variety, and there have, or may, come into existence supervenient hybrid emergents almost limitless in number. Paraphrasing a passage from C. L. Morgan, it is beyond the wit of man to number the instances of emergence, even among the grouse locusts.

In a considerable number of hybrids, to be sure, especially among the higher animals and man, some of the respective characteristics may be blended or arranged in mosaics in such manner as to indicate certain of the qualities of the component races. Even so, such composites generally exhibit, in addition, qualities extraneous to any shown by the original organisms, and at the same time some of the properties of the latter are lost in the process. In this category probably belongs the mulatto, many of whose qualities, in spite of certain degrees of blending, are superveniently different from the mere sum or mosaic of the several characteristics of the white and black races. The respective properties of the ass and the horse would not, by simple addition, or mosaically, make a mule, and the cattalo is far from displaying nothing but the sum or mosaics of the several attributes of buffalo and cattle. Nearly all the higher plants and animals when hybridized—and which are not?—exhibit extraneous qualities such that they largely, or completely effect the dissimilitude of the qualities of their several, contributive, primary races. The list of specified cases could be extended to great length and still remain within the bounds of quite familiar plants and animals. If, on first consideration, the appositeness of some of these illustrations comes into question, it is simply because of our familiarity with the production of such common hybrids. If they were coming into our knowledge for the first time, or if we should approximate precision in estimating their several qualities and appurtenances, as compared with those of the races that go into their making, the novelty of their emergent properties would be quite marked and bewildering.

The tendency to assume that hybrids represent nothing but the sum or mosaics of the characteristics of the races from which they may have been derived has led to numerous signal failures of efforts at producing desirable hybrid composites. Many statements and inferences of plant and animal husbandmen, anthropologists, sociologists and writers in general have brought me to this conclusion. The outlines of several state and federal (U. S. A.) experimental projects, with the expenditure of considerable effort and funds, have been based on this assumption. Familiar examples have been those proposing to develop double-purpose cattle and fowls by hybridizing large beef- with high milk-producing cattle, and high egg-laying with big meat chickens, respectively. The converse of this process have been the efforts, some in the field but mainly in museums, to determine by examination of their characteristics just what had been the original contributive races of various groups of plants, animals and man. It is almost needless to add that the results from most such enterprises have been radically different from those expected and generally disappointing. Even when gains did accrue they were not those aimed at. In general, without previous experience, hybrid emergents may be no better prognosticated than the emergent products of the first syntheses of chemical elements. It even appears to have been a common experience that positive or useful properties were quite likely to emerge from the hybridization of negative or useless characteristics, and *vice versa*.

During the past thirty years the principles of heredity have come to be quite well understood. However, the possibilities of application of these principles in human affairs remain largely to be realized. As noted above, we have not even passed the contingency of developing a strictly scientific technique for the production of valuable hybrid varieties. The uncalculating, extensive methods of hybridization employed by the Burbanks of all time, to such an extent appropriately deplored by scientists, yet in practical results quite successful, may even in this advanced day still remain the irreducible expediency. Since we thus far probably have nothing better in technique to propose, our animadversions might very well be limited to censuring them for failure adequately to record the kinds of crossings and the resulting frustrations and successes. Among the most manifest and importunate requisites of practical biology to-day are great, adequately supported, continuous and perspicaciously conducted projects in hybridization among the respective varieties of the higher animals and plants. The prospects are that progress would be closely analogous with that of chemistry. However, the knowledge of heredity and the casual accomplishments in hybridity already realized would probably make attainments considerably more rapid.

Mutations (neo-Darwinian variations) range from the ordinarily imperceptible, though possibly quite potential under circumstances of hybridism, to those of considerable magnitude. They are of multifarious, chance kinds and utterly without objective. Each new mutant gene in practically any group of higher plants or animals proportionately greatly augments the probabilities of supervenient hybrid emergents. These, in turn, are as much fortuitous sorts and without direction, or objective, as the mutants themselves.

Wheeler states "that there is not on the planet a single animal or plant that does not live as a member of some biocenose." It is likewise probably true that there is no single bisexually reproducing animal or plant which is not in some essential features a supervenient emergent of hybrid syntheses. Hybridity has probably been the efficient, ultimate agency by which the mutant characteristics of all varieties and races of bisexually reproducing organisms, including man, have attained whatever casual, eventual grade of supervenient emergency they may have severally occupied, whether they were among the preponderant legions below the point of ability to survive, those in the situation of being merely tolerated, or the comparatively small numbers which appear to have been reasonably well adjusted.

Natural selection creates nothing; it is strange that anybody ever misunderstood or misstated Darwin to the effect that it does. Mutations and hybridity furnish the materials, mainly, perhaps among the higher organisms wholly, in the form of supervenient individual hybrid and biocenose emergences of fortuitous kinds and without objectivity or direction. The vast majority perish, some linger awhile, others are suffered, while presumably relatively few are fairly well adapted to the dynamic, intra- and interpermeating complexes of the environment; which encompassing complexes are, in turn and in their aspects, as much supervenient emergences as are the intra- and interpenetrating organisms and societies they environ. Here, then, are the exclusive field and materials in and on which it is considered that natural selection operates.

We are probably not yet in the position, certainly it is not intended in this paper, to estimate the share, if any, that should be allotted to hybrid emergence as here defined, in the consideration of the causes of evolution. Bateson's challenge apparently still stands unanswered, at least experimentally; no one has yet demonstrated, either through hybridism or by any other means, a method by which progeny may be derived which are fertile among themselves yet which do not produce fertile offspring when mated back to the original stock.

We are still in a morass, it may as well be admitted, with regard to the ultimate problems of evolution. However, de Vriesian mutations (neo-Darwinian variations)—possibly irradiation-induced mutations, hybrid emergence (emergent evolution) and natural selection constitute features of a rough path, a sort of crude track through the jungle, beaten by Darwin's seven-league boots, that may soon open into somewhat of an upland clearing from which a further reconnaissance may be made.

BIBLIOCHRESIS: THE PILOT OF RESEARCH

By Professor WILLIAM A. HAMOR and Dr. LAWRENCE W. BASS
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Whereby the sedulous worker
His laboratory course does steer.

Bibliochresis, the scientific use of literature, has the pilotage of all scientific investigation. It has, in fact, the same relation to research as the latter has to management; it is the intelligence service of all orderly inquiry, the preparational agent of factual determination, the guide of experimental trial in eliminating chance, in the whole realm of science.

To be scientific, an investigation of any type must be made methodically—a condition that requires, primarily, that all scientific research be conducted in the light of recorded experience. This requirement applies to the exercise of the historical and analytic procedures of investigation as well as to the employment of the experimental method, whose use, whether for confirmation or for original work, rests upon prior knowledge and art, *i.e.*, accepted practice.

Bibliochresis, then, is the most indispensable tool in laying the foundation for scientific research. Since it enables the qualified worker to find the experience of his predecessors, as recorded in the literature, it confers upon him either the power to predict the results of effort—this is the outcome if the recorded information is evidently factual, *i.e.*, definite and confirmed—or the ability to plan further research on the same or an analogous topic. Reference is had throughout this communication to the proper use of the results of bibliochretic study and not to the incorrect employment thereof in the place of indicated experimental investigation. Bibliochresis is never a substitute for needed laboratory research.

The collection of recorded experience—the function of bibliochresis—is plainly the provision of data for facilitating scientific decision and for projecting research. The factual information thus acquired is the groundwork for the comparison and measurement that compose analytic research; it is also the foundation for gaining the new ideas that characterize invention and discovery. Continued progress in science became possible only when the development of the art of printing enabled investigators to make use of the recorded observations of other scientists.

The necessity for a literature search as a prelude to experimental investigation, either disinterested or industrial, has long been an axiom of the scientific professions. The importance of this first step has often been stressed, but rather as a policy of pedagogical value than as a defense of the procedure. Laments at the increasing volume of scientific literature have become hackneyed, demands for more efficient abstracts and reviews have become strident, but these various voices have not been raised against the value of an intimate knowledge of previous researches in a given field.

The wastefulness of needless repetition of experiments already described in the literature and the concomitant inefficiency that allows pertinent experimental findings to remain buried in the library were deplored in a recent editorial in *Nature*.[1] The *Engineering and Mining Journal*,[2] aroused by this article, questioned vigorously the advantages of a literature search as a preliminary to experimental investigation, particularly when a novel technical achievement is the goal. *Metals and Alloys*,[3] a welcome new periodical, has no less firmly taken its stand beside *Nature*.

Of the men best qualified to analyze the factors that lead to high scientific attainment—research directors, personnel managers, experienced investigators, technical editors, educationists—few will deny the necessity of library studies as a discipline for the self-conceit of the researchful mind. The scientific societies and organizations and the philanthropic agencies for the advancement of science have been unanimous in recommending increased use of existing facilities and concerted effort to improve the technical libraries throughout the world. Very recently an officer of the National Research Council has expressed the view that there should be a good working library of science in each educational and industrial center. Such a library would require an initial outlay of at least thirty thousand dollars and a minimal annual expenditure of one thousand dollars thereafter.

The opinion of these authorities concerning the value of bibliochretic work and opportunities is confirmed by several facts.

(1) Bibliochresis occupies a prominent place in the curricula of research training schools. For example, a number of universities are now giving courses in chemical bibliography. Among the text-books dealing with the subject wholly or in part should be mentioned "The Literature of Chemistry," by Crane and Patterson; "Chemical Publications," by Mellon, and "Introduction to Organic Research," by Reid. "Medical bibliography" is another pedagogic innovation.

(2) There is a constantly increasing demand in industrial laboratories for chemical bibliographers, other scientific literary specialists and chemical economists.

(3) The recognition of the need for bibliographic material in compact form is shown by the demand for indexes to the literature, as evidenced by the large number of orders received by their publishers.

(4) Satisfactory incomes, considering everything, are enjoyed by a number of practicing bibliographers who specialize in preparing, for stipulated fees, select bibliographies and also reviews of the journal and patent literature.

(5) Many men have been found to be unsatisfactory in industrial research because of their lack of knowledge of elementary bibliochretic procedure. How often in our personnel work we have seen the criticism of a referee of a candidate to the effect that the latter "was not able to work with ease and interest in literature searches" or "was replaced by a better man because he could not be depended on to make a thorough survey of the literature."

(6) Systematic bibliochresis is the means of establishing authority and originality, in science as well as in history and jurisprudence.

In discussing the subject of bibliographic studies from a broad point of view, several varying requirements must be taken into consideration. The type of literature survey best suited to any given problem must be decided, of course, in each particular case. There is, so to speak, a law of diminishing returns for library work. The handbooks, monographs and other reference manuals give a maximum of information in a minimum of time. When the search is projected into the original literature, the information to be obtained tends to become more and more diffuse as the quest is made more thorough. "Bibliography is as complicated as anatomy, as intricate as physics, as certain as history and as interesting as life itself," is the view of a great medical educationist.

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[1] *Nature*, 122: 913, 1928.

[2] *Eng. Min. J.*, 128: 383, 1929.

[3] *Metals and Alloys*, 1: 197, 1929.

Bibliochretic lists and indexes are often prepared by general agencies for the promotion and encouragement of research. All administration of the proper type must rest on factual information, and hence any methods that facilitate the location of facts are short-cuts to sound management. In providing these indexes, which are of great value as starting-points for bibliochretic studies, such organizations are performing an important service, particularly because it is becoming increasingly difficult to arrange for the publication of material of this kind through the scientific press.

Among the most valuable bibliographies, or classified reference lists of literature, should be mentioned those of C. J. West, of the National Research Council. His "Bibliography of Bibliographies on Chemistry and Chemical Technology," prepared in collaboration with D. D. Berolzheimer, and "Bibliography of Pulp and Paper-Making" are examples of some of the important contributions he has made to the classification of ultimate sources of knowledge. E. H. McClelland, head of the technology department of the Carnegie Library of Pittsburgh, has produced several bibliographies, especially in the realms of ferrous metallurgy and fuel economy, that are classical in their accurate scope. At one time the Smithsonian Institution subsidized the publication of quite a few bibliographies; in chemistry the original aim was to index all the books and periodicals and also the special literature of the elements and of certain important compounds.

Noteworthy examples of bibliochretic studies, or critical indexes of the literature, as they might be termed, are found among the monographs sponsored by various technical organizations, such as those of the American Chemical Society. These books give not only comprehensive lists of references to the original literature, but the author in each case, usually a dean of the investigators in his field, unifies and summarizes impartially the experimental contributions that have been made. The constantly increasing cost of publication and the lack of space due to this factor as well as to the large number of papers that come before almost every editor for consideration have led to the existing preference for select bibliographies. These condensed indexes also save the time and serve the needs of the average reader.

There is considerable difference in many cases between the character of the library work appropriate for academic and that for industrial research. In the field of pure science, searching literature studies are made more or less as a matter of course. Such work is for the most part carried out in universities or research institutes with good bibliographic facilities and with somewhat more deliberate an atmosphere than that in an industrial laboratory. There is usually a professor or research director to plan the investigation, which is generally for a thesis. The problem selected must be reasonably free from overlapping studies in order that the junior author may be assured of a research publication; he is supposed to publish a paper to fulfil all the requirements for his degree, or, at least, he is eager to be able to treasure reprints of an addition to his short list of papers. In either case, the disappointments aroused by finding that his efforts have been dissipated on something already worked out is not to be taken lightly by those who are training our youth for enthusiastic scientific careers. Then, too, his own efforts to make use of the library are not to be overlooked. An exhaustive bibliography is an essential part of his thesis (and it is to be regretted that more theses, with their extended bibliographic studies, are not available for general use). In his conversations with fellow students he incites them to destroy the historical background of his work. Finally, when the completed article is submitted to a journal, a board of editors jealously guard against the duplication of a previous publication. It must be remembered also that the literature pertinent to a problem in pure science is likely to be more easily located than in the case of an industrial project. In spite of all these precautions, unwitting duplication of results is not unknown.

The bibliographic problems of the industrial research man are much more complicated. He is expected to use his time to the best advantage. He must work in libraries that, as a rule, are not so thoroughly stocked as those of the universities, although this condition is being improved markedly. The literature of industrial science is more difficult to follow: the journals for both the technical and pure science publications must be examined; the patent literature must be much more carefully searched than in the case of pure science research; the publications of most interest to him will often contain veiled meanings, and finally, the things for which he is searching may have been done but never published. This last possibility is of the greatest importance in connection with supposedly patentable processes and products.

There are, it is true, some scientists in both pure and applied research who have been eminently successful in spite of the fact that they have purposely refrained from systematic use of the existing literature. They are usually of the genius type, men of great originality and resourcefulness, who would have achieved fame in any field. A noted scientist comes to mind—a heroic figure, inspired, intrepid, a veritable lion of research, yet withal a kindly philosopher whose personal charms have endeared him to two generations of students. His views are that a methodical, mechanical bibliochretic survey cramps his imagination, that it often turns him from profitable paths of research, that he has never been able to duplicate exactly any one's results and, finally, that to him the never-ending joy in scientific work is in finding something he did not know before, even though it might have been found previously by many other workers. Few of us can attain to his heights. As time goes on and the various fields become more and more thoroughly worked over, genius will find it increasingly difficult to assert itself.

It seems to us that the attitude of mind of the man who can achieve continuous research success without using the literature systematically is susceptible to further analysis. He has a profound knowledge of his specialty and he keeps in touch with current progress, although in a desultory fashion. His self-confidence is maintained by his achievements as well as by his grasp of the field. He can therefore plan new work by visualization with reasonable accuracy. Self-satisfaction with his procedure comes to him through his success.

All of us sympathize with this attitude, but it is more than questionable whether it should be encouraged as a matter of general practice. The position of the scientist in the world has changed; he is no longer an unimportant person following the vagaries of researchful imagination, but an important factor in the economic life of a country. Neither industrial laboratories nor research institutions would subscribe to the view that a scientist has fulfilled his duty if he gratifies his personal curiosity by rediscovering old facts merely because he has been too unsystematic to search the literature.

An aspect of bibliochresis seldom emphasized is that, in the hands of a specialist endowed with imagination, trends in research can be analyzed and forecasts can be made with a reasonable degree of probability. The worker can avoid fields in which, from a survey of the literature, it appears that too many groups of workers are engaged to give promise of marked success if he starts in, far behind, to catch up with the others. On the other hand, a particularly keen man can sometimes perceive an important goal which the mass of workers have been too preoccupied to see.

The scientist, scorner of riches though he may be, almost invariably has a certain respect for the acumen and enterprise of the successful business man. The world of affairs, on the other hand, although somewhat awed by the researcher, usually regards him as impractical. It is somewhat paradoxical that the great strides made in business practices during the present generation are in large measure due to the introduction of the scientific method into managemental procedure. Library research has played an important part in all such changes.

Nor has scientific management been neglected by the industries based on science. Before the war there were few persons who could qualify, for example, as chemical economists, but in this respect other fields of management were no further advanced. Now we find in every branch of industry economic surveys of unsurpassed excellence, and the technique of collecting and analyzing such important data is advancing continuously.

Organization is characteristic of the age. All human activities are becoming more and more a matter of coordinated regulation. The dietetically chosen food we buy on a budget plan from a chain store has been systematically approved by city, state and national health officers; it has been distributed, with or without intermediaries, to the retailer according to his calculated sales volume by the manufacturer, who has prepared its reception by scientifically executed advertising; it has been transported over railroads whose interrelations are controlled by governmental regulation based on economic reasoning; the raw materials were selected by means of standardized tests; even the ultimate producers are now being more and more firmly knit together by the economic necessity for management on scientific principles.

The same spirit of organization hovers over the research laboratory, which creates such products. The haphazard methods of the inventor will experience increasing difficulty in competing with organized research, both in pure and applied science. As the literature increases, more and more critical studies will be required, and still larger research units will be obliged to correlate their efforts to avoid duplication. It is not the time to urge less use of the library, but to encourage research workers to follow the literature as never before.

OBITUARY

STEPHEN ALFRED FORBES—A TRIBUTE

On March 13 Professor Stephen Alfred Forbes passed away at Urbana, Illinois, after a brief illness. His end was no doubt hastened by the death of his wife, which occurred on January 24. Despite his eighty-six years, Dr. Forbes was active until within a few days of the end and at the time was the oldest servant of the state of Illinois, which he had served in varied capacities for some sixty years. In his lifetime he had done distinguished work as a soldier, teacher, administrator and researcher such as to command recognition not only at home but also in scientific circles in this country and abroad as well.

Stephen Alfred Forbes was born on a farm in Stevenson County, Illinois, on May 29, 1844. He was of Scottish ancestry, his forbears having come to America before 1660 and his greatgrandfather having been a soldier in the Revolutionary War. When the Civil War broke out he, then a lad of seventeen, enlisted in September, 1861, in the Seventh Illinois Cavalry as a private and was promoted rapidly until made a captain at twenty years of age. While carrying dispatches in 1862 he was captured and spent four months in prison. After a three months' hospital term recuperating from the illness acquired in prison he rejoined his command and served to the end of the war. It was a source of great delight to hear the story of those days when on rare occasions he could be persuaded to relate to younger friends some of his experiences in the field.

Dr. Forbes's interest in nature was no doubt innate but was stimulated in early life by the contact with woods and wild life along Silver Creek, a beautiful stream near his home. The opportunity for formal education was not given there at that time, and the death of his father when he was only ten years old threw added difficulties in his way so that he enjoyed but a brief period of study at Beloit Academy. However, in his early years he was enamored of languages, and by private study he had learned to read French, Spanish and Italian before the war broke out. He took up the study of Greek while in prison.

At the close of the war his mind turned at once to education and he entered immediately on study at Rush Medical College, where he almost completed the course in medicine. But a change of plans led him to teach school in southern Illinois. His own studies in natural history ardently pursued at the same time led in 1870 to the publication of his first scientific articles in the *American Entomologist and Botanist.*

Through the attention attracted by these articles Forbes was named in 1872 curator of the Museum of the State Natural History Society at Normal, Illinois, the seat of the then most prominent educational institution in the state. Three years later he was appointed instructor in zoology at the normal school. In 1877, when the present State Museum was established at Springfield, the Normal Museum, which had become the property of the state, was made the Illinois State Laboratory of Natural History, and Forbes was appointed its director. In 1884 he was called to Urbana as head of the department of zoology and entomology in the young and rapidly developing state university. The State Laboratory of Natural History was transferred by legislative enactment to the University of Illinois, and he remained director until in 1917, with a revision of the state code, it became the Illinois Natural History Survey and he was appointed its chief. This position he held at the time of his death. He was also state entomologist from 1882 to 1917, when the position was merged in the survey. Under his hands the work grew in volume and power until at present it has a staff of fourteen permanent workers and numerous other helpers.

Though carrying large extra time-consuming responsibilities in these state positions he discharged educational duties in the university of major importance. From 1884 to 1909 he was in charge of both entomology and zoology, and after that head of the department of entomology alone until his retirement as emeritus professor in 1921. He served also as dean of the College of Science from 1888 to 1905, and until his retirement was retained by the university senate as chairman of the important committee on university educational policy. He brought about the introduction of natural history into Illinois schools and of laboratory study in its secondary school curriculum.

Despite these heavy official duties, he found time to answer special calls for public service in other directions. At the time of the Chicago Exposition in 1893 he prepared an extensive exhibit of the natural history of Illinois, he served as director of the aquarium and exhibit of the U. S. Fish Commission, and as chairman organized the National Congress of Zoologists held in connection with the exposition. Locally, his influence was steadily exercised in behalf of significant movements. Chief among these ranks the establishment of the Champaign County Tuberculosis Sanatorium, a movement organized and despite serious obstacles carried to a successful outcome under his leadership. Only two years ago the Urbana Association of Commerce had presented him with a special testimonial "in recognition of long, faithful and brilliant public service."

It would be impossible to enumerate here all the civic and scientific organizations at home and abroad in which he held membership or those which had bestowed upon him honorary membership. He joined the American Association early, having been secretary of the section on zoology in 1883, and was also for many years a member and officer of the leading entomological societies. He was a charter member of the Illinois Academy of Science, which had already planned to pay him special honor at the coming meeting to be held in Urbana, May 2. The National Academy of Sciences and the American Philosophical Society had also elected him to membership. A more recent honor was his selection in 1928 as an honorary member of the Fourth International Congress of Entomologists. Among academic honors may be recorded his election to Phi Beta Kappa and Sigma Xi.

Since retiring from active participation in the work of the university, Dr. Forbes has devoted his attention exclusively to the State Natural History Survey and has built up an organization which is widely recognized for its scientific work. The outstanding feature of the work of the survey has been a study of the biological resources of the state. While still teaching he directed an important series of theses on the fresh-water organisms to furnish a basis for the accurate determination of the forms present in Illinois. He himself contributed two magnificent volumes on the fishes of the state, as well as a host of other contributions in the form of reports and discussions of the fauna of Illinois rivers. In fact, his chief work was the elaboration of those relations between organisms and the environment which constitute the basis of the new and rapidly growing field of ecology. In co-operation with his assistants in the Natural History Survey, extensive studies were made of the aquatic organisms of the Illinois River and to him we owe an accurate picture of the changes produced in that stream by the construction of the Chicago drainage canal and the diversion of the current of the Chicago River into the basin of the Illinois River. Because of his work the Illinois River has been declared the best-known stream in the world.

The scientific work of Professor Forbes was diverse in character and conspicuous in all its varied aspects. His publications, which number more than five hundred, cover topics in entomology, ornithology, ichthyology, limnology, ecology and other phases of biology. In many directions he opened up new lines of work and nowhere did he handle his subject in mere routine fashion. The generally high character of his writing was early recognized, and in 1886 the Société d'Acclimatation de France awarded him its premier medal for his scientific publications. His series of eighteen entomological reports contains an immense volume of carefully amassed data regarding the insects of Illinois in their relation to the welfare of the state and includes also extensive studies on methods of combating their attacks which have served to protect the agricultural interests of the state and to profit its workers. While directly useful in a practical way, these reports have embraced also much work of high scientific value. He will always be looked upon as the first and the leading worker in America on aquatic biology. When he started on his studies of fresh-water organisms the inland waters of our country were practically unknown. He was the first man to write on the fauna of the Great Lakes, and to contribute to a knowledge of the food of fishes, a fundamental piece of work for the proper understanding of the factors concerned in solving questions that are involved in the preservation of our commercial fisheries.

Starting at an early date with studies on the food of birds, Dr. Forbes conducted for many years observations on the bird life of Illinois, so well planned and executed that the survey has given an accurate conception not merely of the species occurring in the state, but also of their frequency and exact distribution, which together form a basis for a conception of their true value to agriculture and in the conservation of natural resources also.

The career of Dr. Forbes was unique in several ways. First of all he had enjoyed very little formal education. Unaided he gained command of languages to an extent very unusual in his day and age. He never received a bachelor's degree, and yet Indiana University, under the leadership of David Starr Jordan, granted him the Ph.D. degree on examination and the presentation of a thesis. While teaching he carried on studies in natural history, which were independently developed not merely in a single field but in several to an extent that made men speak of him as the first economic entomologist in America, as the leader in the study of aquatic biology and as the founder of the science of ecology. He was not only a pioneer in these and other fields, but one whose pioneer work laid out intuitively the roads to be followed in future cultivation of those fields. Finally, it was no chance matter that though a pioneer in many new fields he never dropped back as the field opened up and the workers became many. He was always at work and his mind was strong enough and clear enough to grow *pari passu* with the growth of the field, so that in later days he still led the workers engaged there. He maintained his alertness and mental vigor to the last.

In all his writings he manifested a beauty of style that made them unusually appealing, an accuracy of statement that gave them reliability and a keenness of analysis that stimulated the reader and student to mark out his own research along productive lines. He ranks not only as the greatest of Illinois naturalists, but among the few leading students of natural history which our country has produced.

Personally, Dr. Forbes was a man six feet in height, of powerful build, and he walked with a firm military bearing. His speech was quiet and unassuming, his voice clear and pleasant. Before an audience he appeared at ease, and without effort spoke with power enough to reach and hold the largest group in interested attention. While an indefatigable worker, he still had many general interests in life and found time to be the president of the first golf club organized at the university. Later in life driving an automobile was his favorite pastime, and he often chuckled at a comment on his arrest for speeding on his eightieth birthday. He was married in 1873 to Clara Shaw Gaston, whose death only a few weeks ago was a heavy blow to him. His son, Dr. E. B. Forbes, of State College, Pennsylvania, has already achieved distinction in science. Three daughters also survive, Mrs. B. R. Herring, of Chicago; Mrs. F. W. Scott, of Boston, and Miss Winifred Forbes, of Berkeley, California.

HENRY B. WARD

UNIVERSITY OF ILLINOIS

SCIENTIFIC EVENTS

THE UNIVERSITY FILM FOUNDATION OF HARVARD UNIVERSITY

THERE has been established at Cambridge a University Film Foundation, by the aid of a gift made last fall by Mr. John D. Rockefeller, Jr. The foundation is able to make completely both silent and talking films in their plant. A sound-proof studio has been installed, and in connection with it a complete sound-on-film recording equipment, loaned to them by the R. C. A. Photophone. The studio could serve as a center for radio broadcasting, since the acoustic treatment it has received fits it for this purpose.

In addition, the foundation is installing a disc-recording machine which will be employed for transferring the sound-on-film to discs, so that the films will be available with both methods. This machine can be used for making phonograph records and records for broadcasting.

A well-equipped laboratory has been built for developing and printing the films, both standard-width and 16-millimeter size. Mr. Rockefeller's gift has also enabled the provision of more adequate working quarters, editorial rooms and offices for the staff.

During the past six months the foundation has nearly doubled its staff, which now numbers more than twenty persons. In addition to a personnel with college background, specially trained for production and editorial work, the foundation has specialists, such as a sound-engineer, projectionists and a laboratory man.

With this staff and equipment the foundation stands in a position where it can apply modern inventions and technical processes to educational methods. Already, with its previous limited facilities, the foundation has made a large number of educational films in a number of fields. By last September, after one year of existence, the foundation had released twenty reels of films in the fields of geography, biology, anthropology and the fine arts.

The foundation is about to start making a photographic record of eminent professors and personalities connected with the university. This is in line with their work on the Harvard Film, a general descriptive film of the university which they completed last year. That film was, however, silent, and the new films will be talking films. It is planned not only to record the professors' speaking, but also to show them illustrating their experiments and making demonstrations of scientific materials. A talking film on Massachusetts history, with Professor Albert Bushnell Hart depicting the development of the commonwealth, is now all but completed.

THE U. S. PUBLIC HEALTH SERVICE

A BILL for the reorganization of the U. S. Public Health Service has passed both houses of Congress and now goes to the President. Another bill has just been passed by the Senate, but has not yet been passed by the House, providing for the creation of a National Institute of Health, which would greatly expand the facilities for health work by the U. S. Public Health Service. A system of fellowships and provision for accepting donations for special work, such as research work on cancer, is a part of this National Health Institute plan.

Science Service reports that the Jones bill provides for putting the federal health service on a basis which will make it one of the best public health services in the world. There will be more regularly commissioned public health officers and a better chance for a young man in the service to look for promotion. A number of those now under the civil service would be given commissions. The bill aims to put all the public health work of the government departments under one coordinated management as well as to increase the number and kind of commissioned public health officers. Among the provisions of the bill are:

1. That whenever some branch of the government wishes to carry on a public health activity, the Secretary of the Treasury shall detail officers and employees from the Public Health Service to cooperate and direct the work.

2. Whenever special health problems should be studied and certain research or educational institutions have facilities for this study, the Surgeon-General may detail health officials and scientists from his staff to take up their quarters in such laboratories and work there.

3. Great expansion of the Hygienic Laboratory in the District of Columbia.

4. Great increases in personnel under certain conditions. A total of fifty-five officers to be appointed by the President—medical, dental, sanitary engineers, pharmacist officers—and shall be credited with service in the Public Health Service and active commissioned service in the Army and the Navy. All officers and employees other than the commissioned officers in the service shall be appointed under the civil service.

The new bill would put the Surgeon-General of the Public Health Service on a par financially with the Surgeon-General of the Army, increasing his pay to $9,700.

CHEMISTRY AT THE SUMMER QUARTER OF THE OHIO STATE UNIVERSITY

THE department of chemistry of The Ohio State University will offer a greatly enlarged opportunity for both graduate and undergraduate study during the summer quarter for 1930. The first term of the quarter will extend from June 16 to July 23, and the second from July 24 to August 29. A student may register for either term or for the entire quarter. All courses will be presented which are required of undergraduate students majoring in chemistry. Research work and most of the courses prerequisite to advanced degrees will be presented in the fields of analytical, inorganic, organic and physical chemistry.

The following members of the faculty will be in residence: Professors C. E. Boord (organic), W. E. Henderson (inorganic), H. L. Johnston (general and physical), Edward Mack (physical) and H. V. Moyer (analytical). In addition to these members of the regular staff, Professor Thomas Martin Lowry, professor of physical chemistry, University of Cambridge, England, and Professor Richard Allen Morton, University of Liverpool, will be visiting professors in the department.

Dr. Lowry's work in the fields of dynamic isomerism, valence and optical rotation is well known. He will offer a course on optical rotatory power (July 1 to July 23), and one on the physical basis (mainly spectroscopic) of chemical theory (second term). During the second term, Dr. Morton will also present a course on photo-chemistry, in which he will outline some of the newer advances in this field and at the same time he will discuss the recent work of E. C. C. Baly, of the University of Liverpool, which has resulted in the fabrication of certain sugars photosynthetically. In addition, Dr. Morton will present a series of lectures in certain advanced fields of organic chemistry.

Of interest to all graduate students will be courses in chemistry on "Conduction of Electricity through Gases" and "The Application of Thermodynamics to Chemical Phenomena," by Professor H. A. Wilson, of the Rice Institute, and on "Molecular Spectra," by Professor W. W. Watson, of Yale University.

All inquiries and communications with reference to the program should be sent to William Lloyd Evans, chairman of the department of chemistry, The Ohio State University, Columbus, Ohio.

ENGINEERING PAGEANT

DR. GEORGE PIERCE BAKER, of the department of drama of Yale University, wrote a pageant which was presented in the auditorium of Stevens Institute of Technology in Hoboken on the afternoon of April 5, as the main feature of the first day's celebration of the Fiftieth Anniversary of the American Society of Mechanical Engineers. It was in this auditorium that the organization meeting of the American Society of Mechanical Engineers was held on April 7, 1880.

This pageant of the progress of engineering was divided into three parts, entitled "The Beginnings," the "Age of Steam" and the "Age of Electricity." Momentary darkness was followed by motion pictures showing great open stretches of land and sky, and then the natural elements—wind, water, lightning, steam from craters. Neanderthal man, seeing the great forces, is awed. Need creates desire. Curiosity stirs imagination. These give rise to simple invention by which man slightly controls a force in nature. Here is shown the making of the first tools. At the end appears "Control," a child, who uses the words of Carlyle: "Man is a tool-using animal, weak in himself and of small stature, feeblest of bipeds! Without tools he is nothing, with tools he is all." The figure of "Control" develops from a child to a powerful man.

The second part, the Age of Steam, showed the emergence of the mechanical engineer, and centers about Watt and his invention and improvement of the steam engine. The third part introduced the Age of Electricity. This section center around Faraday and Edison. Next come the great inventions since 1880, showing the stages from the earliest to the most modern automobiles, the modest house and to-day's skyscraper, the steam engine of 1880 and the most recent locomotives, the turbine and the great steamships, wireless telegraphy, the airplane, the new engineer as an organizer of labor and distribution, radio and television. Then "Control," full statured, sums up the significance of the inventions, saying, "I am the engineer. All of nature's forces have been made my constant servants in attendance. I control, I convert. I do not create," with the final statement, the motif of the whole celebration, "What is not yet, may be."

SCIENTIFIC NOTES AND NEWS

THE Duddell Medal of the Physical Society of London for 1930 has been awarded to Dr. A. A. Michelson, of the University of Chicago. This award is made annually to one who has contributed to the advancement of knowledge by the invention or design of scientific instruments or by the discovery of material used in their construction.

THE Cameron Prize of the faculty of medicine of the University of Edinburgh for 1930 has been awarded conjointly to Dr. George R. Minot, physician-in-chief to the Collis P. Huntington Memorial Hospital of Harvard University, and to Dr. William P. Murphy, assistant physician in the Peter Bent Brigham Hospital, for their work on the liver treatment of pernicious anemia.

AS a part of the fiftieth anniversary celebrations of the American Society of Mechanical Engineers a luncheon was given at Washington on April 8, at which medals were presented to Dr. C. E. Grunsky, president of the American Engineering Council; Loughman St. L. Penred, editor of *The Engineer*, Great Britain; Brigadier-General C. H. Mitchell, University of Toronto, Canada; Georges Claude, France; Dr. Ing. Conrad Matschoss, Germany; Dr. Masawo Kamo, Tokio Imperial University, Japan; Senator Luigi Luiggi, Italy; Professor Donato Gaminara, Uruguay; Professor Julio Garzon Nieto, Colombia; Hofrat Ing. Ludwig Erhard, Austria; Baron Gaston de Bethune, who received the medal on behalf of seven Belgian engineers; Professor D. Dresden, the Netherlands; Vilhelm F. A. Nordstrom, Sweden; Professor Aurel Stodola, Switzerland; Norberto Dominguez, Mexico; Dr. S. Spacek, Czechoslovakia. The medals were presented by the ambassadors or ministers representing the different countries. Julio Kilenya, portrait sculptor, designed the medal. It symbolizes the engineer and his past and present achievements.

THE Burroughs Medal of the John Burroughs Memorial Association has been awarded to Archibald Rutledge, a writer on nature subjects. Holders of the medal have been William Beebe, Ernest Thompson Seton, John Russell McCarthy and Frank M. Chapman. The award was presented by Dr. Clyde Fisher, president of the association.

DR. C. E. HELLMAYR, associate curator of birds at the Field Museum, Chicago, has been awarded the Megaud d'Aubusson Gold Medal by the Société Nationale d'Acclimatation de France, for his work on South American birds. Recently Dr. Hellmayr was awarded the Brewster Medal by the American Ornithologists' Union.

THE doctorate of laws will be conferred by the University of Edinburgh on Sir William Hardy, director of food investigation, Department of Scientific and Industrial Research; Sir David Wallace, consulting surgeon to the Royal Infirmary, Edinburgh; Professor W. W. Watts, professor of geology, Imperial College of Science, South Kensington, and Professor K. F. Wenckebach, emeritus professor of medicine, University of Vienna.

DR. W. R. BLOOR, biochemist of the University of Rochester, was elected president of the Federation of American Societies for Experimental Biology and reelected president of the American Society of Biological Chemists at the recent meeting in Chicago. Dr. Frederick L. Gates, of the Rockefeller Institute and Harvard University, was chosen president of the American Society of Pathology; Dr. George Wallace, of the Bellevue Hospital, New York, was elected president of the American Society of Pharmacology and Experimental Therapeutics, and Dr. Walter J. Meek, of the University of Wisconsin, was reelected president of the American Physiological Society.

THE retirement after a service of forty years is announced of Dr. William M. Esten, professor of bacteriology at the Connecticut Agricultural College, at Storrs, effective September 1.

DR. RAYMOND C. PARKER, who has been connected with the cancer research organization of the University of Pennsylvania, joined the scientific staff of The Rockefeller Institute for Medical Research on March first.

DR. WILLIAM A. PERLZWEIG, associate in medicine and chemist to the medical clinic in the Johns Hopkins University, has been appointed professor of biochemistry in the Duke University School of Medicine, effective July 1, 1930.

DR. E. L. HILL has been appointed assistant professor of theoretical physics at the University of Minnesota. He will begin his work there in September.

DR. LOUIS EHRENFELD, of Northwestern University, has been appointed curator of organic and industrial chemistry in the Museum of Science and Industry, Chicago; Mr. Herman R. Eberle, of the Michigan College of Mining and Technology, has been appointed assistant curator of mining, and Mr. M. K. Hubbard, of the University of Chicago, has been appointed research associate in geology and geophysics.

DR. H. ROSSBACHER has been made superintendent of manufacturing development at the Kearny, New Jersey, plant of the Western Electric Company.

M. René Baillaud, associate astronomer of the observatory at Marseilles, has been elected director of the observatory at Besançon to succeed the late M. Lebeuf.

R. E. Hellmund, chief electrical engineer of the Westinghouse Electric and Manufacturing Company, has been elected a member of the board of directors of the German Institute of Electrical Engineers.

A consultative committee on cancer research, consisting of representatives of the University of Manchester and of the Manchester Committee on Cancer, has been established. The research work will be conducted in the university laboratories, and will be directed by the committee. Mr. C. C. Twort, M.D. (Aberdeen), who has been working under the direction of the Manchester Committee, has been appointed director of the department of cancer research.

The Board of Conservation and Natural Resources of the State of Illinois has asked a committee consisting of William Trelease, H. C. Cowles, C. M. Thompson and M. F. Walsh to recommend some one for appointment as chief of the Natural History Survey, the position held by the late Professor Stephen A. Forbes. Information about suitable candidates may be sent to any member of the committee.

Dr. W. J. Holland, director emeritus of the Carnegie Museum, Pittsburgh, has left for Mexico City to set up the ninth replica of diplodocus, first uncovered by a Carnegie Museum expedition thirty years ago.

Dr. Remington Kellogg, assistant curator, division of mammals of the U. S. National Museum, sailed for Europe on March 24. He will spend two or three months in an examination of the fossil cetacean types in various European museums.

Mr. M. W. Stirling, chief of the Bureau of American Ethnology, has returned to Washington from Florida, where he excavated a large shell mound and a sand burial mound near Safety Harbor. A large amount of skeletal material was obtained, as well as a good collection of objects representative of the culture of the period.

Mr. N. N. Kusnetzov-Ugamski, of Tashkent, Usbekistan, known for his studies of Hymenoptera, has moved to Samarkand, where he is working in the Research Institute of Meteorology and Hydrology. For the time being, his entomological studies have been discontinued.

Dr. H. U. Sverdrup, professor at the Geophysical Institute of Bergen Museum, Norway, and research associate of the Carnegie Institution of Washington, arrived in Washington on March 1 to spend five or six months there assisting the Department of Terrestrial Magnetism of the Carnegie Institution in the revisions and interpretations of the oceanographic data obtained during Cruise VII of *The Carnegie*. On April 8 Dr. Sverdrup will deliver an illustrated lecture at the Carnegie Institution of Washington on "Some Aspects of Oceanography."

Dr. E. G. Conklin, professor of biology at Princeton University, delivered a lecture on March 29 before the Royal Canadian Institute, on "Some Present Problems of Evolution."

Dr. Henry B. Ward, professor of zoology at the University of Illinois, gave one of the De Lamar lectures at the School of Hygiene and Public Health of the Johns Hopkins University on April 1. The title of this lecture was "The Introduction and Spread of the Fish Tapeworm, *Diphyllobothrium latum*, in the United States."

Dr. Winthrop J. V. Osterhout, member of the Rockefeller Institute for Medical Research, New York City, will deliver the seventh Harvey Society Lecture at the New York Academy of Medicine, on Thursday evening, April 17. His subject will be "Electrical Phenomena in the Living Cell."

On March 29, Dr. Edgar L. Hewett, of Santa Fé, New Mexico, lectured at Chapelle House, Denver, Colorado, on the Indians of the Southwest, with special reference to the ruins of ancient pueblos.

Dr. George B. Cressey, professor of geology and geography at Shanghai College, China, gave a series of five lectures on the geography of China at Clark University commencing on March 31. Dr. Cressey is spending his sabbatical year as research associate at Harvard University and instructor at Clark University.

Dr. William Mansfield Clark, professor of biological chemistry at the Johns Hopkins Medical School, gave at the Harvard Medical School on April 1 and 2 the Cutter Lecture on Preventive Medicine. The subject of his lecture, which was given in two parts, was "Reversible Oxidation-Reduction in Organic Systems."

Dr. J. Frenkel, professor of theoretical physics at the Polytechnical Institute at Leningrad, will lecture on "Wave Mechanics" at the University of Minnesota during the academic year 1930–31. He will also conduct a seminar on problems in modern physics.

On the occasion of the fiftieth anniversary of the foundation of the Ophthalmological Society of the

United Kingdom, on April 3, the Bowman Lecture was given by Sir Arthur Keith. The lecture was entitled "The Genius of William Bowman."

The American Geophysical Union will hold its eleventh annual meeting on May 1 and 2 at the National Academy-Research Council Building, Washington, D. C. The sections of geodesy and meteorology will meet on the morning of May 1 and the sections of oceanography and volcanology in the afternoon. The sections of terrestrial magnetism and electricity and of seismology will meet on the morning of May 2 and the general assembly of the union will be held in the afternoon. The section meetings will be preceded by short business sessions and will include reports on national, international or cooperative progress, as well as scientific papers in each field, except in the case of the section of seismology, the meeting of which will be for business purposes only, as a joint meeting for the presentation of scientific papers is planned with the eastern section of the Seismological Society of America at Washington on May 5 and 6. Following the business session of the general assembly to consider reports of officers, there will be a scientific session on "The Utility of Geophysics" consisting of a series of six papers, one from each section of the union.

The eleventh International Congress of Zoologists will be held at Padua from September 4 to 11, under the presidency of Professor Paolo Enriques. Excursions after the meeting to the valleys of Comacchio, Ferrara, Bologna and Ravenna are planned.

Construction on the new building in Cambridge for the Biological Institute of Harvard University will begin shortly. Plans have not yet been completed, but the Boston *Evening Transcript* states that it is expected that the building will contain no lecture halls, as those in the University Museum fulfil present needs. Instead, it will be devoted to laboratories, research rooms and administrative offices. The site, which has been definitely picked out, is the plot of ground across Divinity Avenue from the museum, a little to the east of Divinity Hall and the Semitic Museum.

Teachers College, Columbia University, receives $500,000 by the will of the late V. Everit Macy.

The Medical School of Washington University, St. Louis, has received from E. Arthur and Frank E. Ball, manufacturers, of Muncie, Indiana, a gift of $60,000 for research in hearing at the Oscar Johnson Institute.

According to a press dispatch, the House of Representatives has voted to create a Textile Foundation to spend and administer a fund of about $2,000,000 for scientific and economic research in the textile and allied industries. The bill provides that the Textile Alliance, a corporation formed immediately after the war to protect the American textile industry in the purchases of dyes, should pay to the new foundation about $2,000,000, which it was supposed to turn over to the government. Under the terms of the charter of of Textile Alliance, it was supposed to make no profits, but through its dealings immediately following the war, to prevent a demoralization of the dye market, it actually came out more than $2,000,000 to the good. The bill provides for a board of directors of the foundation, to be composed of the Secretary of Commerce, the Secretary of Agriculture and three individuals familiar with the textile industry, to be appointed by the President for terms of two, three and four years. The bill gives the directors wide powers in administering the fund, with the provision that an annual report be made to Congress.

The new Institute for Cancer Research was opened at Villejuif, near Paris, on March 17, by M. Doumergue, President of the Republic. He was accompanied by M. Marraud, Minister of Public Instruction, and M. Desiré Ferry, Minister of Public Health. After the opening ceremony the President laid the foundation stone of the new hospital which is to be erected beside the institute. In an address on the work of the institution, M. Ferry said that the importance of a close liaison between the laboratory and the hospital could hardly be overestimated. To the sufferers in hospital would come all the relief that lay in the power of the research worker, who in his turn would be helped to fresh achievement by their practical observations of the progress of the disease. The International Congress on Cancer opened at the new institute on March 18.

The Royal Institute of Public Health, London, has been called on to give up its present site in Russell Square. The lease extends over several more years, but the site is required for the University of London, and the London County Council has served notice that in order that road widening may be carried out the demolition of the institute building is required. After an extensive search of the surrounding district by Sir William Smith, the principal, the institute has acquired a site a short distance away, on which new buildings will be erected. The site acquired is one of the few remaining open spaces in London available for building purposes. It is the plot of land on the north side of Queen Square, with frontages to the square and to Guilford Street. The institute was founded in 1886, incorporated in 1892 and received royal recognition in 1897. Its headquarters were established in Russell Square in 1905. Here laboratories were constructed for chemical, bacteriological and other research work. The courses of instruction given in these laboratories are recognized as qualifying medical practitioners for admission to the examinations for degrees and diplomas in public health of all the universities and medical corporations in the kingdom.

INDICATIONS of extensive commercial research in Soviet Russia are shown, as reported in the *U. S. Daily*, in large exports from the United States of various types of scientific, laboratory and professional instruments and apparatus in 1929. Soviet Russia became the second most important market for this class of materials last year, being exceeded only by Canada, which is the leading purchaser of American scientific appliances. The shipments to Russia amounted to $400,816, and accounted for a large part of the 23 per cent. gain in the year's exports of these commodities. The total shipments in this group, which is classified as "other scientific, laboratory and professional instruments and apparatus," aggregated $4,344,640 during the year. The materials include scientific instruments for testing physical strength, materials and forces; chemical and physical apparatus, aeronautical, astronomical and bacteriological instruments; graphic recording, military and naval, meteorological appliances; microscopes, laboratory scales, thermometers, barometers, hygrometers, magnets, etc. The exports of these materials showed a gain also during the month of January, when shipments amounted to $344,763, an increase of 13 per cent. over the corresponding month of 1929.

DISCUSSION

A SACRIFICE TO PELE

DOWN along the thinner borders of the lava overflows from Kilauea, which four years ago surged out into the fern forests and cut off some acres of them, where Pele's glowing strands had floated round, I noted last October that many of the tree fern stumps, somewhat pocketed in the light and fluffy lavas from one to three feet thick, seemed again to come to life. Could that be? I asked, and was told it was apparently so.

Then I looked over about an acre of the former fern forest, noting many of the stumps which seemed to send up the gnarled, irregular shoots, rather large for the time in which they had appeared, if grown from spores and prothalli. No soil seemed to have gathered over these shoots; their roots were imbedded deeply in the chaffy tops and remnants of the old stumps. No other plants or ferns of any kind whatever were to be noted round about, although the rough, deeply furrowed lavas should have favored soil forming and the growth of prothalli. Without previous and continued observation of the stumps from the time of the flows and without the digging up of the stumps from beneath the lavas, it seemed necessary to consider the amazing explanation of survival. Not knowing the forms of the fern forest very well, I can't say which of the several species was concerned, or how.

Could a surging, fiery spray of thinning waves of basaltic lava of extreme liquidity, flowing rapidly about the fern trunks with their heavy mat of wet, insulating chaff, perhaps with accompanying torrential rain, cool quickly enough to leave strands of the fern stumps still alive? And then, with initial rootlet cell growth, could a stalk cell form, and life begin anew? This much is certain: the liquid lava temperatures, usually recorded as from 800° to 1,200°, would be nowhere near so high about the fern stumps while the free tops of the forest were cut down. There would also form about the chaffy outer mass a jacket of steam which would hold the lava away from the stems as water from below made its escape. The trunks themselves and the fern forest floor would be further protected by a dust and ash coating precedent to the flow. The lava is very vesicular.

Recently the subject of reforestation following devastating eruptions, especially at Krakatau and at Katmai, has claimed some further attention. It has been found that the destruction of the original flora is not so extreme as earlier supposed. Certainly, ferns do come up from beneath the ash when it is washed away by the rains.

G. R. WIELAND

YALE UNIVERSITY

BRANCHING HABITS OF THE HEVEA RUBBER TREE

MANY tropical trees have specialized habits of branching, which may be viewed as adaptations to forest conditions. Darwin and many other writers have recognized that forest vegetation in the tropics must meet an intensive competition for space and light. Chances of survival are greater for seedlings or saplings that can outgrow the surrounding vegetation and reach the sunshine. The seedlings of Hevea are specially adapted to undergrowth conditions in tropical forests.

Instead of beginning to branch near the ground, as do the more spreading trees of temperate climates, the specialized tropical species send up at first a tall, slender stalk, with branches only at the top. The

Central American rubber tree (Castilla) forms temporary branches on the lower part of the trunk, different from the permanent branches that appear later. Coffee, cacao and cotton are other examples of plants that have specialized lateral branches, different in structure and function from the uprights. In such cases the branches are said to be of two forms, or dimorphic. Several systems of dimorphic branching are known, though botanical text-books usually treat only of monopodial and sympodial systems, which may or may not be connected with dimorphism. The branch specializations undoubtedly should receive greater attention from morphologists than has yet been given.[1]

In the development of the Hevea tree two distinct growth periods or phases may be recognized, as in the cacao (Theobroma) and the patashte (Tribroma). The juvenile phase covers the growth of the primary upright, while branching signalizes the adult phase. The upright is built of a long succession of internodes whose buds normally remain dormant, though able to replace a lost or damaged terminal bud. The upright develops by flushes or spurts of growth, with each of the growth-sections ending in a close-set cluster or whorl of leaves. Lower internodes of the growth-sections often are four or five inches long, and sometimes six to nine inches, while the internodes that produce the leaves in the terminal clusters are only a quarter or an eighth of an inch in length. The interrupted growth, suppressed buds and pronounced inequality of the internodes are specialized features.

The adult phase of Hevea usually begins with a terminal whorl of branches, though not so definitely specialized as in Theobroma and Tribroma, which have regular numbers of branches in the whorls, five and three respectively. Also in the Ceara rubber tree (*Manihot glaziovii*), a relative of Hevea, the branches are regularly in threes. In Hevea, whorls of three, six and twelve branches occur, as well as intermediate and larger numbers of branches. Even where the branches of Hevea are not definitely clustered, the main stalk loses its predominance. Adult Hevea trees are essentially candelabrum-like, seldom showing any tendency to retain a strong central axis.

The primary upright of Hevea usually attains ten to twelve feet, and often fifteen to twenty feet, before any branches are formed. Some of the trees fork at five or six feet from the ground, especially those that have been cut back or injured, while others form several whorls of abortive branches before the permanent branches develop. Under forest conditions, branches that do not have upright or ascending positions are not likely to be permanent, but are overshadowed and die. Border trees may develop rather large horizontal branches, but these become topheavy, twisted and diseased. The normal habit of the species is shown by the slender, few-branched forest trees, rather than by the more spreading open-grown trees.

Propagation of Hevea from cuttings was reported by several experimenters in the East Indies soon after the first introduction from Brazil, but efforts in recent years to root cuttings from mature trees are reported as complete failures. Readier rooting of cuttings by the first experimenters may be connected with the fact that the lower section of the trunk has the power of producing adventitious roots, and only seedlings were available in the early years. Rooting above the crown has been observed at Chapman Field, in southern Florida, in experiments where the level of the soil has been raised by top-dressing. The root swells in advance of the trunk, and may attain nearly twice the diameter, a few inches below the surface of the soil. The enlargement of the trunk at the base is an important feature as determining the extent of tapping surface accessible from the ground.

Propagation from buds of high-yielding trees has been practiced for several years in the East Indian rubber plantations, but the budded trees are reported to differ generally in having narrow cylindric trunks, not thickened at the base as in the normal trees. This behavior has been ascribed to incompatibility and great variation in the stocks, but may be a consequence of specialization of the branches. The ability to regenerate uprights may be lacking in the lateral branches of Hevea, as in those of Theobroma and Tribroma. The lateral branches of coffee and of the Central American rubber tree also fail to produce uprights, and are not of use for vegetative propagation, although sections of the uprights are readily rooted.

Thus the specialized habits of branching in Hevea may throw light on cultural problems which hitherto have remained obscure. The commercial cultivation of Hevea did not begin till 1896 and has been confined largely to the East Indies. Recently it has been learned that Hevea can grow in southern Florida and is more tolerant of cold than many other tropical types. A Hevea tree has survived for nearly thirty years in an open-air planting at Palm Beach, and is still vigorous and healthy, though of small size.

O. F. Cook

Bureau of Plant Industry

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[1] "Dimorphic Branches in Tropical Crop Plants: Cotton, Coffee, Cacao, the Central American Rubber Tree and the Banana," U. S. Department of Agriculture, B. P. I. Bulletin 198, 1911. "Branching and Flowering Habits of Cacao and Patashte," Contributions from the U. S. National Herbarium, Vol. 17, Part 8, 1916.

WHAT IS CONTROL?

The application of insecticides is now called control by the vast majority of entomologists, as is that of fungicides by practically all mycologists. Formerly the medical terms, remedy, treatment and preventive, prevailed. The writer has checked over more than a hundred of the most recent Experiment Station bulletins on insects and fungi and finds less than 5 per cent. of the writers using the latter terms in the place of the term control.

The reason for the change was perhaps a reaction against the idea that remedies are, or should be, effective as eradicative measures. It became very evident that what could be accomplished was not a cure of the trouble, but only sufficient mitigation to make it possible to obtain a satisfactory crop, so the term control was introduced and has finally practically displaced the older terms.

In a few of these publications, the term control is made to include the action of parasites and predators, just as in the days of Riley they were spoken of as natural remedies, as contrasted with artificial remedies.

The term control carries the thought of definite conscious action of a rational being, something done by man for his own benefit. It may be indirect through a mechanism he has set up, but it is always something that carries out his will. According to the older thinking, certain actions of nature were also conceived as controlled by an intelligence who ordered everything for the benefit of man and of individual men, and thus we had natural remedies administered by this higher power who used parasites and predators as his agents. Either the retention of this conception of nature, or more likely, the unthinking retention of this form of statement gives us now natural control.

Contrasted with this is the use of the word uncontrolled, which is almost universally expressive of the action of nature where a control by man is not exercised. Natural control is thus a contradiction of terms, because it is equivalent to non-control, and should disappear from the literature of entomology.

C. W. Woodworth

OESTRUS FOLLOWING THE REMOVAL OF ONE OVARY

In a recent number of Science[1] it was pointed out by Nelson that a pregnant rat had copulated several times during the gestation period and that young were born and suckled. After the lactation period oestrus again occurred but subsequent matings were infertile. These observations are interesting not only from the standpoint of oestrus during pregnancy but also because in this case one ovary had been previously removed. It is well known[2] that the removal of one ovary results in the so-called hypertrophy of the remaining ovary with the formation of many follicles. These changes may be accompanied by disturbances in the various phases of reproduction.

During the past year the writer has studied more than a hundred rats with respect to oestrus before and after semioophorectomy. It was found that the oestrus cycle was slightly shorter during the first few weeks following the removal of one ovary and that the usual cornified cell stage representing the heat period occurred at quite regular intervals. After two months the remaining ovary had considerably increased in size and the cornified cells in the vaginal smears occurred more frequently. The number of these cells and the frequency of their occurrence were variable. Some animals had normal cycles, while others were in heat most of the time. Indeed, with a few rats one could not tell with certainty when one cycle ended and another began.

TABLE I

Frequency Distribution for Length of the Oestrus Cycle of Fifty Rats. A, Before Operation; B, After Removing One Ovary

Length in days	No. of cycles		Total days involved	
	A.	B.	A.	B.
2	0	34	0	68
3	6	71	18	213
4	116	256	464	1024
5	314	249	1570	1245
6	117	97	702	582
7	22	23	154	161
8	11	11	88	88
9	3	1	27	9
10	1	1	10	10
11	0	2	0	22
12	0	2	0	24
13	1	2	13	26
14	0	1	0	14
Total	591	750	3046	3486
Mean			5.15	4.65
Probable error			± .0272	± .0344

As shown in Table I the average oestrus cycle of fifty rats after the removal of one ovary was significantly shorter than the normal period. The mean difference in this case was 0.50 days, a figure more than ten times the probable error of the difference, which is ± 0.044. These figures, although indicating a shorter oestrus cycle in the rats after operation, are not entirely without fallacy. As mentioned above, it often is difficult to determine the duration of any one cycle because of the large number of scales present daily in the vaginal smears; irregular cycles may also occur in apparently normal animals.

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[1] W. O. Nelson, Science, 70: 453, November 8, 1929.

[2] C. G. Hartman, *Am. Jour. Anat.*, 35: 1, March, 1925.

The rats considered in Table I were observed daily during a period of four months before operation and during a similar period after operation. It would seem unlikely, therefore, that these changes are incidental. Other experiments now under way confirm the results shown in Table I.

Frederick E. Emery
University of Buffalo

A NEW RECORD OF CASTOROIDES OHIOENSIS FROM ILLINOIS

A perfect skull of the giant beaver, *Castoroides ohioensis* Forster, has been sent to the Museum of Natural History of the University of Illinois for identification. It was found in a gravel pit on the farm of Mr. W. A. Paullin, near Bellflower, McLean County. While the details of the find are not very clear as regards stratigraphic relationships, it is evident from the perfect condition of the skull and also from the presence of clay in the brain cavity and in other parts of the skull, containing fresh-water mollusk shells, that the skull lay at the base of the gravel which was outwash from the Champaign moraine, covering the Shelbyville till sheet which underlies the Champaign till sheet in this region. That the specimen was originally buried in a lake or other body of water is clearly evidenced by the diverse character of the molluscan fauna found in the clay, which included the following species.

Sphaerium sulcatum
Pisidium species
Valvata tricarinata
Amnicola leightoni, var.
Cincinnatia cincinnatiensis
Pyrgulopsis species
Pomatiopsis scalaris
Helisoma antrosa striata
Gyraulus altissimus
Gyraulus urbanensis
Ferrissia paralella

The stratigraphic horizon of the deposit in which the skull was found is Early Wisconsin, substage 1 of Leverett, or the earliest division of the Wisconsin stage of the Pleistocene. *Castoroides ohioensis* has been reported from all interglacial intervals of the Pleistocene, from Aftonian to post-Wisconsin, and is known to have lived in pre-Glacial time. Five records[1] are known from Illinois previous to the present specimen; these are: Shawneetown, Gallatin County, teeth fragments, Le Conte, 1852; Charlestown, Cowles County, skull, Leidy, 1869; Naperville, DuPage County, Bannister, 1870; Quincy, Adams County, Worthen, 1870; Alton, Madison County, Worthen, 1890. The animal was evidently wide-spread over Illinois, the records covering the length and breadth of the state.

The Bellflower specimen is being studied by Dr. A. R. Cahn, of the University of Illinois, who will make a detailed report of the specimen.

Frank Collins Baker
University of Illinois

PROFESSIONAL ETHICS AND THE ARTIST

Dr. Stiles' article "Absent-mindedness as a Factor in Professional Ethics"[1] brings up a point which scientists may well consider. There is, however, a prologue to the same story which I believe is an even worse ethical abuse than that to which Dr. Stiles calls attention. This is the practice, frequent among scientists of standing, who employ an artist or illustrator to do their illustrations, of denying this artist the right to sign these drawings or illustrations, and in no way making any acknowledgment of the true authorship of these drawings.

The defense is often raised that the artist deserves no credit because he or she is paid to do this work. However, so are scientists usually paid for their work, by government, university or private agency, and yet they invariably claim full credit for all their work (sometimes some of it questionably theirs) by affixing their own signatures. Again it is sometimes advanced that illustrations are very incidental, only a minor feature of a paper—something akin to the services of the stenographer in typing the manuscript. That this theory is also false is clearly shown by the incidents described by Dr. Stiles where illustrations are repeatedly copied by other authors, often without the slightest change. Dr. Stiles objects that in this copying acknowledgment should be made to the original author, the supposed source of the illustration. Why then should not the original author also acknowledge the *real* source of the illustration where it is the work of an artist, and not his own?

It is usually emphasized that these drawings are "made under supervision," as though the artist were merely a machine for mechanically recording the inspiration of the scientist. It is true, of course, that such drawings are made under direction, but the amount of it is in some cases so trivial as to be negligible. Furthermore, many illustrators, after a short novitiate in a particular line, understand what is wanted with only the barest suggestions from the superior, and proceed to solve all the smaller difficulties (and sometimes the larger) by themselves, in the execution of the work. I have personally known of several cases in which the careful, intelligent study of a specimen by the artist revealed details that the scientist had missed completely in his own shoddy haste. Even cases where the scientist worked from the drawings instead of from the specimens!

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[1] Baker, "Life of the Pleistocene."

[1] Science, 71: 100–101.

My point is that many illustrations for which no credit is given are as truly pieces of research as the manuscript which they are designed to accompany. Perhaps most scientists have the view that the artistic ability required to do a good illustration is really a rather ordinary faculty—something equivalent to learning to run a typewriter—and as such meriting no recognition on a plane with their own lofty genius trained to grapple with the problems of science, like the old gentleman in the operetta who admitted he had never written a sonata, but felt perfectly confident that he could if he ever desired. This delusion is frequent and could be cured by compelling such scientists to do their own illustrations until they could do them as well as their artists.

I believe I may claim to understand both sides of the question, inasmuch as I have studied art as long and as seriously as I have science, and have served an apprenticeship at scientific illustration myself, now discontinued for concentration upon the esoteric and rarified problems of parasitology. And it is my experience that it takes as much brains and training to do an acceptable illustration of a difficult subject as it does to tackle the average scientific problem. Some government bureaus are flagrant offenders in this way, also many workers of prominence in the universities. It is not contended that every diagram, however simple or trivial, should necessarily bear the name of the artist, or receive acknowledgment, but where a piece of writing is accompanied and often greatly enhanced by an elaborate series of illustrations which are not the handiwork of the writer it is plainly dishonest for the scientist tacitly to take credit for this part of the work. If it is not permissible for scientists to filch illustrations from each other it is a "distinction without a difference" that permits them to be filched from the artist. An illustrator's only chance of progress is through recognition of his work. Certainly the most altruistic scientist would object if compelled to publish all his work under the veil of anonymity. Moreover, there is often more real research and honest investigation in the unequivocal lines of a good illustration than there is in many of the padded, purloined and pilfered "contributions" that swell the scientific literature of to-day.

JUSTUS F. MUELLER

NEW YORK STATE COLLEGE OF FORESTRY

SPECIAL CORRESPONDENCE

STATEMENT IN REGARD TO PROFESSOR EINSTEIN'S PUBLICATIONS

BEFORE the time of Faraday and Maxwell, electric forces and magnetic forces were known, but they existed as distinct things, having no apparent relation to each other. To cause magnetic forces to exhibit themselves it was necessary to cause them to act upon magnets, and to cause electric forces to become manifest it was necessary to allow them to attract or repel other charged bodies or attract neutral bodies, but the presence of any magnetic state in those neutral bodies had no apparent effect upon the electrical phenomena. Then, when as the result of the experiments of Oersted, Faraday and others, it was found that a magnet was influenced by an electric current, and an electric current by a magnet, the whole question of the relation between magnetism and electricity became opened up. A composite theory developed in which magnetic and electric forces were intertwined, so that one could not speak in general of the forces upon a moving charge in terms simply of the electric forces, but had to include the magnetic forces as well. Neither could he speak of the forces upon a magnet entirely in terms of what were formerly regarded as magnetic forces, but had to introduce the electric forces as well. Then, for a long time, we had electric forces and magnetic forces harmoniously intertwined, but gravitation standing apart in the same sense as the electric and magnetic forces themselves had stood apart before the days of Faraday and Maxwell. Einstein's new theory as developed a few months ago did the same kind of thing for electric, magnetic and gravitational forces as was formerly done by Maxwell and Faraday for electric and magnetic forces. A composite theory intertwining all three was successfully produced. Just as in the purely electromagnetic problems, there were special cases of the composite structure in which the forces involved were purely electrical, the magnetic ones being negligible, and other cases in which the forces involved were almost purely magnetic, the electric ones being negligible, in such manner as to have suggested originally that these two types of forces were entirely indistinct, so in the composite theory involving magnetism, electricity and gravitation there are certain special cases in which the gravitational aspects are all-important to the exclusion of the electromagnetic, and others in which the electromagnetic aspects are all-important to the exclusion of the gravitational. So far our experimental researches have concerned themselves with cases of this kind, so that it has been our philosophic desire rather than the needs of experiment which has driven us to hope for a correlation of gravitation and electromagnetism in one general scheme.

A complete presentation of any physical theory involves two parts: first, a statement of the general laws governing the phenomena, and second, an application of the laws to some specific problems of interest to us. Thus in the time of Newton, the scientific thought of the day agitated itself concerning the consequences to be expected from the supposition that the heavenly bodies attracted each other with forces which varied as the inverse square of the distances between them. This constituted the general law, but it remained for Newton to show that one of the consequences of this law was that a planet would travel around the sun in an ellipse with the sun at one focus. This constituted the solution of a particular problem based on the general law.

Again when in 1915 Professor Einstein brought out his general theory of relativity some of the most interesting consequences resulted from his success in applying it to the motion of a planet around the sun, to the motion of a beam of light past the sun and to some of the peculiar motions of the heavenly bodies which were not readily understandable in the Newtonian theory.

It now appears that Einstein has succeeded in working out the consequences of his general law of gravity and electromagnetism for two special cases just as Newton succeeded in working out the consequences of his law for several special cases. It is frequently very difficult to solve special problems illustrating the application of a general law, yet the practical value of a law is enhanced in proportion to the extent to which it is capable of being applied to practical problems. When some actual problem arising in a general theory has been solved, we are in a position to formulate experiments on the basis of that problem with a view to testing the general theory underlying it. It is hoped that the present solutions obtained by Einstein, or if not these, then others which may later evolve, will suggest some experiments by which the theory may be tested.

W. F. G. SWANN

BARTOL RESEARCH FOUNDATION OF THE
FRANKLIN INSTITUTE,
SWARTHMORE, PENNSYLVANIA

CONFERENCE AT CHICHEN ITZA

DURING the third week of January there was held at the archeological field station of the Carnegie Institution of Washington at the ruins of Chichen Itza an informal conference of persons interested in development of researches bearing upon the history of man in the Yucatan peninsula. The following were present: Sr. Eduardo Martinez Canton, inspector of archeological monuments for the State of Yucatan, representing the Mexican government; Dr. F. M. Gaige, biologist, of the University of Michigan; Dr. Robert Redfield, social anthropologist, of the University of Chicago; Mr. C. L. Hay and Dr. George C. Vaillant, archeologists, of the American Museum of Natural History; Dr. George C. Shattuck, of the Department of Tropical Medicine, School of Public Health, Harvard University; Dr. A. M. Tozzer, chairman of the department of anthropology, Harvard University; Dr. Eyler N. Simpson, of the Institute for Current World Affairs, and Dr. S. G. Morley, Mr. Karl Ruppert, Mr. H. B. Roberts and Dr. A. V. Kidder, archeologists, of the Carnegie Institution.

The purpose of the gathering was to discuss, without agenda and in a purely preliminary way, the desirability of bringing to bear upon the historical problems of the area the resources of various disciplines and to consider methods for the prosecution of cooperative research. It was accepted as a premise that historical evaluation of the archeological facts derived from the excavations of Dr. Morley and his staff would be rendered immeasurably more precise by the accurate knowledge of environmental conditions which could be supplied by specialists in biology, geology, meteorology, etc.; and of information as to human factors, past and present, which could be collected by workers in documentary history, medicine, comparative linguistics and the several social sciences. It was taken for granted that the findings of such non-archeological specialists would not only be of intrinsic value to the sciences represented by them, but that they would gain cumulative importance because geographical concentration would permit pooling of data, interchange of ideas, as well as formulation of combined attack upon problems of common interest. It was felt by the majority of those present that precise statement of objectives and rigid organization would be unwise; that research should be allowed to flow in such channels as the shifting contours of individual investigations might throw open; and that propinquity and the mutual interest stimulated by simultaneous attack upon related problems would lead naturally to a more effective type of cooperation than could, in the present embryonic state of most methodologies, possibly be planned in advance.

The conclusion, therefore, was that all studies should be independent, intensive and highly specialized, and that limited and definite goals within each science should be aimed for. A historical view-point, in the broadest sense (in other words a consciousness of the implications of the time element in the recording and interpretation of phenomena), should, however, be adhered to; and close but informal touch should be maintained among all workers in order that they should keep cognizance of the methods, the general trends and the bearing upon their own fields of each other's activities.

The above more or less theoretical aspects of the matter having been considered, attention was turned to specific investigations and stock was taken of researches in progress or in contemplation. At present under way are the following: Archeological work at Chichen Itza, under direction of Dr. Morley, now in its seventh year; excavations at Uaxactun, Department of the Peten, Guatemala, under direction of Mr. O. G. Ricketson, Jr., fifth year; heiroglyphic research by Dr. Morley; ceramic survey of the Maya area by Carnegie Institution, being inaugurated during the present year by Mr. Roberts (all the foregoing are projects of Carnegie Institution); medical survey of the Yucatan peninsula by Harvard University and Carnegie Institution, now in its second year; records of Chichen Itza clinic administered by Miss MacKay, third year; biological reconnaissance (1930) by University of Michigan, Dr. Gaige; ethnological reconnaissance (1930) for Carnegie Institution by Dr. Redfield, of the University of Chicago; studies of Maya linguistics at Chichen Itza by University of Chicago, Dr. Andrade (1930).[1]

Proposed activities of the Carnegie Institution are: historical work on the Conquest and the Colonial Period; retranslation and collation of the books of Chilam Balam; investigation in physical anthropology by Department of Genetics; air-survey of Maya area. All the above were discussed, and consideration was given to the relation to various aspects of the project of climatology, geology, sociology, psychology, etc. Advantage was taken of the presence of Messrs. Tozzer, Hay and Vaillant to review in detail the local archeological investigations of the institution, to consider its wider implications and to solicit their advice as to future activities.

A. V. KIDDER

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

LABORATORY AND TEACHING DEVICES MADE FROM PLASTER OF PARIS

OCCASIONS in the teaching and research laboratory often arise when an irregularly shaped vessel or chamber is desired or when one wishes to construct a teaching model which will greatly resemble the original. For this purpose plaster of Paris has long been used. Several decades ago A. Edmunds[1] used it for the construction of kidney and intestinal oncometers. More recently the writer has had occasion to employ it for both teaching and research apparatus.

Some time ago while teaching a general course in hygiene and public health at the summer session of a normal school, the writer discussed the utility and necessity of septic tanks in rural or semi-rural communities. The difficulties in explaining the various features of septic and Imhoff tanks were well-nigh unsurmountable. This led to the idea of constructing small models of these tanks.

Using the proportions given in the standard text and reference books, but greatly reducing the dimensions, foundations were made from wire cloth such as is used in screen doors; the corners were either bound with fine wire or soldered. It was found best to use small wooden strips as stretchers inside of the frame until after the first, external, coat of plaster had hardened. These stretchers were then removed and a coat of plaster was applied to the internal surface of the wire. After this coat had hardened, irregularities were removed by scraping with a knife, rubbing with coarse sandpaper or by the application of a thin mixture of plaster of Paris rubbed down with the fingers. Small brass pipes were used at the points where the inflow and outflow pipes are regularly found.

When constructing Imhoff tanks, it was found best to make the floor and side walls of the settling or upper chamber of glass plates in order to render the interior of the sludge chamber visible. The sludge pipe was made from a piece of ⅜-inch brass pipe to which was soldered a short length of the same sized pipe at a 15° angle. This latter short piece of pipe was passed through a hole made in the side wall of the model after which repairs to the wall were made with plaster.

Recently during an investigation of the circulation of the liver,[2] the writer found it necessary to construct an air-tight chamber suitable for receiving the livers of cats, dogs and rabbits in their natural position while fluid was being perfused through them. In this case a V-shaped box was made from ¼-inch wire netting, the corners soldered, and this box was covered with plaster of Paris in the manner described above. Here, however, the open edge was built up well above the wire frame and nearly an inch wide. When the plaster was well hardened, the box was held in the obverse position and the edges about the open end were ground smooth with sand paper so that a piece of glass would form a closely fitting cover. A beeswax-vaseline mixture of proper melting-point was found satisfactory for tightly sealing the cover on the hepatic oncometer and cotton saturated with this mixture was used to seal the openings provided for the inlet and outlet cannulae. The oncometer was rendered impervious to air and water by means of the methods described below.

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[1] A. Edmunds, *Journal of Physiology*, 22: 380, 1898.

[1] Summaries of the results of these units of work will appear in the Year Book of the Carnegie Institution in December, 1930.

[2] A. R. McLaughlin, *Journal of Pharmacology and Experimental Therapeutics*, 34: 147, 1928.

These models may be rendered air- and water-proof by heating them in an oven or hot air sterilizer until they are thoroughly dried. While still so hot that they must be handled with cloths, melted paraffin is poured into the model. By rotating the model, melted paraffin may be made to permeate all parts of the plaster, thus rendering it air- and water-tight, or it may be painted with spar varnish or brushing lacquer both inside and outside. This varnish treatment is most satisfactory for the models of the septic tanks since they may then be handled without being soiled. Dust may also be removed without leaving the plaster in a smeared condition.

SUMMARY

A method has been described whereby models of septic tanks for teaching public health and oncometers for physiological demonstration and research may be constructed by employing a wire frame and covering it with plaster of Paris.

These models should prove especially useful to teachers in rural and suburban communities and to extension workers whose task it is to keep a vast number of our population informed as to the best measures of protecting their health.

These models may be rendered impervious to air and water by means of paraffin, varnish or brushing lacquer.

ALVAH R. MCLAUGHLIN
UNIVERSITY OF WYOMING

ELIMINATING OPAQUING BY ALTERNATING BLACK AND WHITE BACKGROUNDS WHILE MAKING A PHOTOGRAPH[1]

PHOTOGRAPHS of most biological subjects are more pleasing if the finished print has a white background. Such backgrounds are ordinarily secured by placing a piece of white cardboard or an illuminated ground-glass behind the object to be photographed. Unsatisfactory ones are often "blocked out" with some opaquing material, but this procedure is always tedious and, in the case of some biological subjects, impossible. Unfortunately many subjects whose print value would be enhanced by a white background refuse to yield satisfactory negatives when photographed against white backgrounds. Thus, such subjects as yellow, hairy, dark-spotted caterpillars, or sections through diseased potatoes, when photographed against a piece of black cloth yield negatives that present the object with excellent detail and gradation, but the resulting picture (print) will have a drab tone because of the black background. The loss of detail when using a white background is accountable chiefly to the great difference in exposure required by the background as compared with the object itself. Obviously it requires far less time to photograph a piece of white paper than a dark object. The white background literally overexposes a large portion of the negative as a result of the additional time required to record the object itself. Hence the white background induces sufficient halation and "fog" to obscure both the detail and color value of the outer portion of the object.

The writer's method for avoiding this difficulty consists in using a black background (black cloth) during most of the exposure, but towards the end of the time required by the object itself, inserting a piece of white cardboard so that a white background will result in the finished print. By experience it has been determined that for ordinary lighting conditions a pure white background is insured by inserting a white cardboard as background for not more than one third the total time required by the object. At first both backgrounds were used in the same plane, but after several trials better results were obtained by placing the white cardboard closer to the object and keeping it in position for only one fourth the total exposure required. This method almost entirely eliminates halation and records the desirable qualities in the negative which one expects from a black background, but insures a white background in the finished print.

The technique for carrying out the black-white background procedure is very simple. The object to be photographed is placed on a piece of plate glass mounted conveniently beneath the camera. A piece of black velvet photographic cloth is stretched at a distance of about six inches beneath the object on the glass, and the camera is then stopped down so that the exposure for the object itself will require at least twenty seconds. A large square of cardboard is held in readiness for insertion during exposure. First the shutter is opened and the negative exposed for from two thirds to four fifths the required time; then, at the end of this period, the white cardboard is put in position about two inches beneath the glass and, at the end of the total exposure, the shutter is closed. For example, if twenty-five seconds is required for optimum exposure of the object, the first seventeen seconds should be with black cloth only, and the last eight with the white cardboard inserted. For large objects, such as a potted plant, the same effect may be obtained by hanging a white cardboard on a wire so that it may be drawn back and forth as needed.

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[1] This method was developed at the Virginia Truck Experiment Station, Norfolk, Virginia.

Occasional subjects require a gray background. Any shade of gray may be obtained by varying the time for white and black. Obviously the longer the time with black, the shorter with white, the darker the background produced.

This method will eliminate the tedium of opaquing and blocking out of negative where black backgrounds have been found desirable in making the negative but undesirable in the print.

The writer intends to use a modification of the method for making photomicrographs. For this purpose it will be necessary to prepare a substage, the illumination of which may be alternated by white and black disks such as are provided on binocular microscopes.

FRANK P. MCWHORTER
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SPECIAL ARTICLES

COMPONENTS OF AIR IN RELATION TO ANIMAL LIFE

OXYGEN, since the time of Lavoisier, has been considered the vital component of the air. The 79 per cent. inert part has had little use assigned to it. Popular opinion had stated that animal life would be more efficient if these inert gases were replaced by oxygen.

Carefully conducted experiments, covering a period of eight years, have been carried out by the writer and his assistants.

A glass jar of five-gallon capacity was used as an air-tight container for the larger animals and a gallon bottle for the smaller ones. The gas was introduced through holes in a stopper fitting the larger mouth of the container, entering at the top and passing out near the bottom. The natural feed for the different animals and water were kept before them constantly. A small container of sodium hydroxide was placed at the bottom of the jar to take up any excess of carbon dioxide. The outflow of gas from the glass jar was passed through lime water to show that carbon dioxide was given off and the speed of the escaping gas.

The gas in the jar was frequently tested quantitatively, and the analysis showed that it never had an excess of carbon dioxide over that of ordinary atmosphere. A very accurate record was kept of the rate of breathing and the general appearance of the animals. Chemically pure oxygen was used.

Animals can not live in an atmosphere alone of oxygen, nitrogen, carbon dioxide, helium or argon. In a series of thirty experiments it was found that small animals such as mice, rats, pigeons, cats, guinea-pigs, snakes, monkeys, etc., can live in a medium of air under control, but in pure oxygen under the same conditions they will die within from two to five days. In only one case did any of the animals live over a week in oxygen—the snake lived four weeks—while in a current of air we had the different animals under control from one to three weeks without any signs of ailments. With the representative varieties of animal life it was found that in an atmosphere of pure oxygen, with other conditions normal, without a single exception every one would die in oxygen and none in air.

The breathing of the animals was usually found to increase gradually at first in the oxygen atmosphere, but later they appeared to breathe with more difficulty and more slowly until they died. From the appearance of their actions they did not seem to suffer much from pain.

AUTOPSY SHOWS HEMORRHAGE

An examination made by Dr. G. S. Terry of the lung tissue from a guinea-pig which had died in an atmosphere of pure oxygen showed marked evidence of inflammation and interstitial hemorrhage. Cultures made from the lung tissue showed a heavy infection of *Bacillus coli* associated with a few Staphylococci. The conclusion drawn from the autopsy was that an atmosphere of oxygen would not only rupture the lung tissue but also accelerate the growth of certain micro-organisms.

CARBON DIOXIDE AND OXYGEN

Animals were placed in an atmosphere of 99.97 per cent. oxygen and the normal .03 per cent. of carbon dioxide by volume. The animals used for these experiments were guinea-pigs.

With these experiments of carbon dioxide and oxygen the condition of the animals was found to be about the same as with pure oxygen. For this series of four experiments some one was watching them and taking observations day and night.

The general belief that animals could live with the normal amount of carbon dioxide that we have in the atmosphere added to the oxygen tested out to the contrary. Death followed in every case within two to five days as in the oxygen experiments.

THE EFFECT OF PURE OXYGEN UPON WATER ANIMALS

The experiments were continued with water animals in pure oxygen which was passed continuously through the water. The animals for these experiments were different kinds of fish, tadpoles, snails, newts and water turtles.

Some distilled water was boiled so that the mineral matter and most of the air would be removed to see if there could be any difference from that of tap water. The general results were found to be the same. These water animals tested out just the opposite from the land animals. In this case the pure oxygen could not have had such a burning effect when diluted with water which also soon became saturated with carbon dioxide.

An Atmosphere of Helium and Oxygen

Seventy-nine per cent. helium and 21 per cent. oxygen form an atmosphere under which animal life will exist normally, or in some cases apparently even better. Mice were used for these experiments. Observations were taken every fifteen minutes day and night.

An Atmosphere of Argon and Oxygen

By using argon instead of helium and with the same percentage mixture the animals (mice) would not survive as they did with helium. The argon mixture would diffuse through the living cells less rapidly than the natural air and the helium more rapidly. The density of nitrogen compared to air is .967, that of argon 1.379 and helium .138, which might account for this difference.

By using 87 per cent. argon and 13 per cent. oxygen the mice would live forty-two hours. The respiration of the animals decreased slowly until death but without any apparent suffering. An atmosphere of 80 per cent. argon and 20 per cent. oxygen permitted life for ninety-two hours. Using 75 per cent. argon and 25 per cent. oxygen supported life normally, if not better than normal air, so far as we could observe.

An atmosphere made up of 66 2/3 per cent. argon and 33 1/3 per cent. oxygen supported life but not normally as with a higher per cent. of argon. The mice after six or seven days' confinement in such a mixture would be in poor health. The point of highest efficiency had apparently been passed.

An Atmosphere of Nitrogen and Oxygen

Natural air contains 21 per cent. oxygen, 78 per cent. nitrogen and 1 per cent. mixture of argon, neon, krypton, xenon, helium and carbon dioxide. An atmosphere which contained 21 per cent. of oxygen and 79 per cent. of nitrogen by volume was prepared, leaving out the rare gases. The experiment was repeated six times. Blank tests with normal atmospheres were under simultaneous observation. White mice were used as experimental subjects. No difference in the physiological effects was noted because of insufficient atmosphere supply.

This series of experiments led to the conclusion that the rare air gases such as argon, helium, neon and carbon dioxide are vital for normal respiration. Without these rare gases included with the normal amount of nitrogen and oxygen, life would not exist longer than ten days. The rare gases seem to play a part in normal life equally as important as oxygen.

By increasing the mixture of oxygen to 25 per cent. and decreasing the nitrogen to 75 per cent. the animals were under control for three weeks without any signs of ailment. The experiments were continued by using mixtures as follows: oxygen 30 per cent. and nitrogen 70 per cent.; oxygen 40 per cent. and nitrogen 60 per cent.; oxygen 50 per cent. and nitrogen 50 per cent.; oxygen 60 per cent. and nitrogen 40 per cent., when the animals appeared to be normal and in a few cases better than in the normal air. By making a mixture of oxygen 70 per cent. and nitrogen 30 per cent. they seemed abnormal after being in this atmosphere for about a week. In an atmosphere of 80 per cent. oxygen and 20 per cent. nitrogen they would die in nine days, and they would live but seven days in an atmosphere of 90 per cent. oxygen and 10 per cent. nitrogen.

In an atmosphere of pure nitrogen alone the animals would live but six minutes; in argon alone, three minutes; in pure oxygen, from two to six days, and in hydrogen thirty-seven minutes.

From these experiments with pure oxygen and with the different mixtures of oxygen and other gases it seems that one might be able to find a mathematical curve between the mixture of gases and the time of living with animal life.

In a number of cases it was found that artificial atmospheres could be prepared that supported life in white mice more effectively than the normal air we breathe every day.

In the field of practical applications of prepared atmospheres there is a wide range of commercial uses and values. In deep-sea diving, mines and submarines foul air is encountered and there is often a lack of sufficient amount of air to sustain life. A prepared atmosphere for such activities would broaden their respective ranges of usefulness. An artificial atmosphere in a submarine that sustained life even more effectively than normal air would bring about a safer and more efficient submarine. A prepared atmosphere would be a great advantage to the high altitude fliers.

Medical men have a fair knowledge of the action of oxygen in the air, but little is understood by them concerning the other gases, especially the rare gases.

It is quite possible that a knowledge of atmosphere may aid in the control of diseases. The widest field probably will be in the pathological application.

J. Willard Hershey

McPherson College

SOME CONSTITUENTS OF DERRIS AND "CUBE"[1] ROOTS OTHER THAN ROTENONE

Since the introduction of derris root extracts as insecticides, rotenone has been considered mainly responsible for their activity. However, reports from entomologists and others interested in insect control indicate that derris extracts may contain little or no rotenone and still be effective sprays, and also that extracts from which rotenone has been removed as completely as possible are still effective. It may be assumed, then, that such preparations contain materials other than rotenone possessing insecticidal properties. In this connection it is significant that Greshoff,[2] Tattersfield and Roach,[3] Sillevoldt[4] and Durham[5] have isolated various products from derris root, some of which were toxic to fish or insects while others were not. None of these products, however, has been examined chemically.

Recently it has been shown that rotenone is present abundantly in the Peruvian fish poison "cube,"[6] extracts of which are used to some extent as an insecticide in South America. Like derris root, "cube" yields a large quantity of non-crystallizable material, which remains in the rotenone mother liquors.

In the course of a survey of fish-poisoning plants as sources of insecticides which is now being made in this laboratory, the non-crystalline extractives of derris and "cube" roots were studied to determine whether it was possible to obtain any material of definite composition that might be responsible for their physiological action upon fish or insects.

Without entering into details of the methods employed, which will be published elsewhere, it may be stated briefly that, when the non-crystalline material from all samples of derris root thus far investigated was dissolved in methyl or ethyl alcohol and treated with a small quantity of dry sodium carbonate or dilute sodium hydroxide solution, a number of well-defined crystalline compounds were obtained and that invariably three substances predominated. One of these, toxicarol, is a greenish-yellow substance which crystallizes in thin hexagonal plates that melt at 218°–20°. It is a monohydroxy dimethoxy compound, $C_{23}H_{22}O_7$. Another substance, with a pale green color, crystallizes in rodlike plates, having a melting-point of 171°. It is a dimethoxy compound, $C_{23}H_{22}O_6$, and is thus isomeric with rotenone. Recently toxicarol and this second compound have also been found in *Cracca* (*Tephrosia*) *toxicaria*.[7] The third substance crystallizes in short, thick prisms which melt at 198°. It is a dimethoxy compound, $C_{23}H_{22}O_7$, and is possibly tephrosine, which Hanriot obtained from the leaves of *Cracca* (*Tephrosia*) *vogelii*.[8] Although Hanriot reported the melting-point of tephrosine at 187° and assigned to it the formula $C_{31}H_{26}O_{10}$, his preparation was likely impure, consisting in all probability of a mixture of tephrosine and the 171°-melting compound, since the writer found that the leaves of *Cracca* (*Tephrosia*) *vogelii* gave a mixture of these two materials which had a melting-point of about 187°.

Besides the three substances just described a variable number of yellow or orange compounds were found in small quantities in the crude crystalline mixture, but since they are extremely difficult to separate in an analytically pure condition they have not as yet been investigated.

When the rotenone mother liquors from "cube" roots are submitted to the same treatment as described for derris, they also yield a crystalline mixture, which has proved to be either tephrosine (melting-point 198°) and the 171°-melting compound found in derris and cracca or a mixture of these two compounds and a yellow crystalline dimethoxy compound having a melting-point of 217° and the formula $C_{22}H_{20}O_6$.

The yields of these products, both from derris and "cube," are remarkably high. Some specimens of derris, which yielded less than 1 per cent. rotenone, gave by the alkaline treatment as much as 4 to 5.5 per cent. of the crude crystalline mixture, and the samples of "cube" thus far available yielded uniformly about 5.5 per cent. of a 2 to 1 mixture of tephrosine and the 171°-melting compound.

Further work is in progress upon these substances, but from the analytical data now available it appears that all these compounds, including rotenone, are more or less related, and that this small group of chemical compounds may be responsible for the toxic properties of many widely distributed tropical fish-poisoning plants.

E. P. Clark

Bureau of Chemistry and Soils,
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[1] Pronounced coo′ bay. Recently Killip and Smith, *Wash. Acad. Sci.*, 20: 73, 1930, identified the plant as *Lonchocarpus nicou* (Aubl.) D. C.

[2] M. Greshoff, *Pharm. Journ. and Trans.* (3), 21: 559, 1890.

[3] F. Tattersfield and W. A. Roach, *Ann. Appl. Biol.*, 10: 1, 1923.

[4] H. E. Th. Sillevoldt, *Ned. Tijd. Pharm.*, 11: 246, 1899; *Arch. Pharm.*, 237: 595, 1899; *J. Chem. Soc.*, A., 1: 109, 1900.

[5] Durham, reported in footnote 3.

[6] E. P. Clark, Science, 70: 478–9, November 15, 1929.

[7] E. P. Clark, in press.

[8] M. Hanriot, *Compt. rend. Acad. Sci.*, 144: 150, 1907; *Compt. rend. Soc. Biol.*, 62: 884, 1907.

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PROFESSORS' SALARIES[1]

ARE EQUITABLE SALARIES PAID TO PROFESSORS?

By Dr. WILLIAM A. NOYES

PROFESSOR OF CHEMISTRY, UNIVERSITY OF ILLINOIS

The professors in our colleges and universities are not receiving their fair share of the returns coming to others from the rapidly increasing prosperity of the country. No one will claim that professors were overpaid in 1900. In order that they may retain their economic status in comparison with other men and women their salaries must be increased in the same proportion as the income of the average citizen. Salaries have fallen far below this equitable level.

The volume of "Statistical Abstracts" of the United States published by the government in 1928 gives the following numbers in millions of dollars for the values of farm products, mineral products and the values added to raw materials by manufacture in the years 1900 and 1925:

	1900 Millions of Dollars	1925 Millions of Dollars
Farm products	3,549	13,034
Mineral products	1,110	5,678
Manufacture	5,123	26,778
	9,782	45,490

To avoid an unfair use of the statistics for farm products, it should be stated that the farm population remained stationary during this period, while the total population increased 50 per cent., or from 77.1 millions to 115.4 millions.

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[1] A symposium on the salary question arranged by the Committee of One Hundred on Scientific Research, American Association for the Advancement of Science, Shrine Lounge, Des Moines, Iowa, December 31, 1929.

Dividing the values of the products by the population, we have a per capita production of $128 in 1900 and of $394 in 1925. We may put this concretely by saying that where an individual received for his labor and capital, on the average, $100 in 1900, he received, on the average, $300 in 1925.

This gives, however, a very exaggerated idea of the increase in our powers of production. The average of the index numbers for wholesale prices for the years 1898–1902 was 77.7. The similar average for 1923–27 was 152. In other words, a gold dollar was worth just about one half as much in purchasing power in 1925 as it was worth in 1900. Making allowance for this change in the value of the dollar, the increase in the real value of our production was about 50 per cent. instead of 200 per cent.

Salaries and wages are paid, however, in the depreciated money indicated by the index numbers, and it would seem to be a fair conclusion that, if professors in our colleges and universities are to maintain the same economic status relative to other classes of citizens which they held in 1900, their salaries must be increased threefold. A professor of a given rank who received a salary of $2,000 in 1900 should have received $6,000 in 1925. There are doubtless some factors which make this conclusion not wholly accurate, but we may take it as approximately true until some one is able to furnish a statistical analysis which will prove its fallacy.

To determine how closely this equitable basis for salaries has been approached, the presidents of nine universities were asked to furnish a statement of the average salaries paid to executive officers who do no teaching and to professors, associate professors and assistant professors, in 1900 and in 1925. The presidents of Yale, Harvard, Ohio State, Michigan, Illinois, Wisconsin and California furnished the data requested. The other two universities were unable to do this. I wish here to express my appreciation of the courtesy shown in furnishing this information. The averages are given in the table.

AVERAGE SALARIES

	1900	1925	Increases
Executives	$3,115	$6,904	122 per cent.
Professors	2,791	5,318	87 per cent.
Assoc. professors	1,956	3,895	99 per cent.
Asst. professors	1,605	3,004	87 per cent.

MAXIMUM AND MINIMUM AVERAGE SALARIES AND INCREASES

	Max. 1900	Min. 1900	Max. 1925	Min. 1925	Per cent. increase Max.	Per cent. increase Min.
Executives	$5,598	$2,050	$8,470	$5,562	208	0
Professors	4,002	1,958	7,008	4,550	161	44
Assoc. prof.	3,950	1,350	5,077	3,665	130	28
Asst. prof.	2,351	1,412	4,000	2,642	199	44

An examination of these statistics makes it clear that the economic position of professors in these universities is not so good in relation to other members of the community as it was in 1900. While the income of citizens, in gold dollars, has increased, on the average, about 200 per cent., that of these professors has increased less than 100 per cent. When we take account of the index numbers, the value of the salaries paid in 1925 was somewhat less than the value of the salaries paid to men of the same rank in 1900.

A report by Dr. W. Hardin Hughes, director of administrative research for the city schools of Pasadena, California, was published in August, 1929. It gives a very careful and exhaustive analysis of salaries paid in the city schools of Pasadena in 1928 in comparison with those paid to wage-earners in other callings. Dr. Hughes reports that in comparison with 1914, taking account of the index numbers, "the average income of all persons gainfully occupied in the United States in 1928 had actually gained 57 per cent. in purchasing power." This is in surprisingly close agreement with the conclusion reached above. It makes it quite clear that it is not fair to professors that their salaries should be increased merely in proportion to the change in the purchasing value of their salaries. The salaries should be increased in proportion to the increased income of the average citizen.

A concrete illustration will help us to see this. Since 1900 a very large proportion of the people of the United States have found it possible to own or use automobiles. This is one direction in which the 57 per cent. increase in the income of the average citizen is being used. We realize what an immense addition to the convenience and richness of our lives this has made. Is it not right that professors should be able to take advantage of these changes, as well as other citizens?

Men and women who take the degree of Ph.D. in chemistry go partly into industrial positions and partly into academic work. A comparison of the salaries paid to the two classes of individuals throws further light on the reasons why many of our most brilliant graduates do not follow academic careers.

During the years 1918 to 1928, inclusive, 146 men and women received the degree of Ph.D. in chemistry at the University of Illinois. In the fall of 1928 a letter was addressed to these graduates asking for a statement of the initial salary received after graduation and the salary received in 1928. Replies were received from all but three. Sixty-one engaged in academic work soon after graduation and have continued in such work. Fifty-three accepted and have continued in positions in industrial work. Fourteen entered academic work but left it for industrial positions. Two were in industrial work for a time but are now teaching. Thirteen have gone into medicine, hold fellowships, live in foreign countries or for other reasons can not be included in the average.

In academic positions, the average initial salary, including income from summer teaching or other work, was $2,407. For industrial work, the average initial salary was $2,845.

In 1928 the average salary of persons who had taught for four to ten years was $3,472. The average salary of persons who had held industrial positions for four to ten years was $5,619.

The highest initial salaries for academic work were one of $3,500 paid to a woman in a woman's college; $3,056, including summer teaching, paid to a man who returned for graduate work after some years of teaching, and $3,000. Two other incomes exceeding $3,000 included incomes from industrial work.

The highest salary for academic work in 1928 was $4,500, paid to a woman for teaching part time and doing executive work in a high school. The next two were $4,450 and $4,433, each including teaching in a summer school.

The three highest initial salaries paid for industrial work were $4,800, $4,000 and $3,840.

The highest salaries paid for industrial work in 1928 were $15,000, $13,000 and $11,000.

The University of Illinois offers courses in chemistry and in chemical engineering which require the study of chemistry for four years and include a minor amount of research during the senior year. An inquiry was directed to the graduates of these courses for the years 1919 and 1925. The results of this inquiry were not sufficiently extensive to justify a detailed report, but they indicate quite clearly that a man entering academic work with the degree of Ph.D., usually four to six years older than the man who takes a bachelor's degree, will receive, on the average, only about $400 more than the bachelor. Ten years later, the salary of the doctor in an academic position is, on the average, less than that of the bachelor in industrial work.

Chemists who are employed as teachers in our best colleges and universities are receiving far less than their fair share of the threefold producing power gained by the country during the last twenty-five years. Teachers who enter an academic career after receiving the degree of Ph.D. have, on the average, after five to ten years, a much smaller income than those who engage in industrial work.

It seems evident that unless these conditions can be remedied our universities must be content to fill their teaching positions with mediocre men.

The very slow increases in academic salaries are a just reason for complaint. We should seriously question whether the present policy of many universities to employ a much larger number of recently graduated doctors of philosophy than can hope for reasonably rapid promotion to salaries on which they can support a small family and care for their own professional needs for books and for attendance on professional gatherings is justifiable. Shall we not contribute more to the development of high standards by employing fewer people and giving more rapid and adequate promotion to those who are worthy?

During the last twenty years it has been necessary, repeatedly, to fill major positions in the department of chemistry at the University of Illinois. After looking the country over, with the aid of friends, it has often been found that the quest has narrowed down to only two or three who were suitable and possibly available at the salary which could be offered. Even then, it was found, on several occasions, that the men selected would not come. Sometimes the position was left vacant for a year and the search continued. In other cases the position was filled with a young man of unusual promise and he was then given a rather light load of teaching and allowed time and facilities for research which made it possible for him to make for himself a position of importance in the chemical world.

It is an open secret that Harvard University has tried very earnestly but has failed to secure a man of established reputation to fill the place of one who had grown up from the ranks to a position of international fame.

Professor Harper gave to the University of Chicago much of its initial prestige by calling a few men of national and international reputation at salaries of $7,500, which was much above any salary paid at that time in the middle west. To maintain a similar standard, to-day, the university should have a few professorships with salaries of at least $20,000. If some university will have the courage, to-day, to do this and to break away from that lock-step promotion, which is so fatal to the encouragement of men of exceptional ability, it will help to remove the very objectionable differences in rate of promotion in the universities and in the industries.

Dr. A. D. Little, who has built up a very strong organization of chemists working on industrial problems, permits me to quote him as saying that he has "found it advantageous and profitable to pay the salaries necessary to secure men whose records lead their professors in the institutions they have attended to recommend them as exceptionally capable."

The great leaders in science have been men who were inspired by other great leaders who went before them. Liebig studied with Gay-Lussac, Wöhler with Berzelius, Faraday with Davy, Pupin with Helmholtz, Nef with Baeyer. The necessity of providing great leaders in our universities can not be overemphasized. To do this we must pay such men adequate salaries. It is, perhaps, of even greater importance that we should give young men of promise adequate time and facilities for research and that they should be promoted when they have shown their worth.

In a recent paper published in SCIENCE, the claim was made that salaries are inexorably fixed by the law of supply and demand and that it is useless to try to tamper with a law which the author of that paper seems to think is sacrosanct.

Such an attitude treats human beings as on the same level with the inanimate products of their labor. Sociologists are generally agreed that other factors beside supply and demand should be taken into account in determining wages and salaries.

Foremost among these is the "living wage" which is necessary to maintain the efficiency of the worker and enable him to provide suitably for those dependent on him. Surely the "living wage" for a professor should be on a higher plane than that of a day laborer. No one can do efficient work unless he is freed from the anxiety which comes from the attempt to make an inadequate salary cover the bare necessities of life. He should have a sufficient income to free him from that anxiety and to make it possible for him and his family to form reasonable social contacts with other cultured men and women. In addition to that he should be able to purchase the books which are the tools of his trade and to travel and associate, occasionally, with colleagues in his field, at home and abroad.

Henry Ford has recently stated a principle which he thinks should be considered by employers of labor. By increasing the wages paid to workmen their ability to purchase the products made by other workmen is increased. This is a recognition of the fact that under modern conditions production is limited, not so much by the number of workmen required and by the cost of machinery used, as by the market for the goods produced.

During the few years of the great war the position of the United States was changed from that of a debtor nation, with many of its securities held abroad, to that of the most powerful creditor nation in the world. This happened because we had the ability to speed up mass production and meet the emergencies of the war. The most important material losses of the war were not, as many suppose, the munitions and other materials used and destroyed, for these were almost entirely made during the war. The losses which have caused such a dislocation of economic relations are due to the transfer of wealth from one nation to another and from one class of citizens to another.

One of the lessons of the war which we should all learn and take to heart is that the people of the world are now able to make valuable products far more rapidly than the citizens of the world are able to buy them. If the salaries of professors could be doubled overnight, their scale of living would rise rapidly and they would furnish a market for products in such a manner that their increased receipts would mostly find their way back into the pockets of other citizens. In a sense, this is an illustration of the old saying, "Nothing succeeds like success." Henry Ford's principle is, within limits, essentially sound. In the long run, even on the rather low basis of economic prosperity, the use of the money of the people to increase the salaries of professors would contribute, materially, to the possibility of increased production and to the general prosperity of the country.

Another factor worthy of careful consideration is the value of the services rendered to the community. The increase in salaries which we are asking should not be considered as a charity to underpaid men and women. They should be considered as an attempt to pay a part of the debt which the community owes for the services professors render.

Liebig founded a laboratory which has transformed and democratized the teaching of science, not only in Germany but throughout the world. When Prince Albert wished to establish a scientific institute in London, he called to his aid Professor A. W. Hofmann, one of Liebig's students. The first of the coal-tar dyes was discovered and developed by W. H. Perkin, who studied with Hofmann.

The synthesis of alizarin, or turkey red, was discovered by Graebe and Liebermann, working in a German university. Germans did not, at that time, succeed in manufacturing the dye, but Perkin, with his experience in factory production, succeeded so well that as early as 1881 it was stated that the turkey red manufactured in one year was worth $8,000,000 but that it would have cost $28,000,000 to make the same amount from madder root, formerly used as the source of the dye.

In spite of this initial success in England, the manufacture of dyes was soon transferred almost completely to Germany. This happened because there were in Germany many young men trained in research in laboratories similar to the one founded by Liebig.

Baeyer discovered a synthesis of indigo about 1880, and a manufacturing company worked for twenty years to convert the discovery to a commercial success. The company could not succeed till two other discoveries were added, one made by a professor in Holland and the other by a professor in Switzerland.

Professor Haber, formerly of Karlsruhe, developed the synthesis of ammonia from hydrogen and the nitrogen of the air. This discovery is destined to add greatly to the food resources of the world. Without it Germany would have been defeated in the great war in six months.

Michael Pupin is a graduate of Columbia, and he studied at the University of Cambridge and with Helmholtz in Berlin. He has done much to make long-distance telephony practically possible.

The first electrical manufacture of aluminum was invented by the Cowles brothers, students at the Case School of Applied Science in Cleveland. A second, more important, method was discovered by Hall as the result of a statement made by Professor Jewett in a lecture at Oberlin College.

Such illustrations could be multiplied by the thousand, and it would be easy to show that the wealth added by the work of professors in colleges and universities very far exceeds the cost of the maintenance of all these institutions.

The illustrations have been taken from chemistry and physics, but it would be a mistake to suppose that only scientific faculties are worthy of support. It is not necessary to argue the importance of training in other subjects than science. My own academic career was begun at Grinnell College, then a small western institution. There, Professor John Avery, who taught me Greek and German, was one of those who inspired me to a life of productive scholarship.

In conclusion, I wish to make the following practical suggestions.

(1) The executives of our colleges and universities should redouble their efforts to secure equitable salaries for their professors. They should see clearly that to secure able and efficient men in charge of the various departments and divisions of their work and so to relieve them from routine work that they may continue to be productive scholars as well as efficient teachers is the most important function of the institution.

(2) Positions as instructors should be given only to those young men, to be found anywhere in the country, who have the best training in the subject to be taught and who give most promise of becoming both efficient teachers and productive scholars. These requirements are more severe, in general, than the requirements for men who might succeed in industry, and the salaries should be rather higher than lower than the salaries paid for industrial work. In other words, executives should seek the best, not the cheapest.

(3) Such men after appointment should be given ample opportunities and time for productive scholarship and should also be encouraged to become efficient teachers.

(4) The number of instructors appointed should bear a close relation to the possibility of a rather rapid promotion for those who show exceptional ability.

(5) Lock-step promotion—a regular increase each year, almost irrespective of accomplishment—an easy device of executives to avoid trouble—should not be tolerated. Men of unusual ability should be promoted rapidly, as they are in the industries.

(6) New lines of work should be undertaken only when there are ample funds to support them. The California Institute of Technology set an admirable example when it refused to establish a department of biology before ample funds for its support were available without depleting the money needed for other departments.

ADEQUATE SALARIES FOR COLLEGE AND UNIVERSITY TEACHERS

By EDWARD A. FILENE

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I have been asked to address this body upon the question of adequate salaries for university and college teachers. I have been asked to speak, however, upon only one phase of the question, that is, the social importance of such salaries. That immediately presents a difficulty, particularly to a business man. I confine my talking, usually, to business groups, and to tell the average business audience that something is socially important is not to tell it very much.

Every business man in America to-day knows that high wages for everybody are socially desirable. Not many of them know, however, just how they, individually, can make wages higher. They suppose that higher wages must be paid out of profits and, with competition what it is, they do not feel justified in cutting their profits any thinner. For that reason, although I profoundly believe in raising wages, I never suggest to business groups that they ought to raise them. I tell them, rather, to raise their wages so that their total profits may be greater, and that is more likely to make a business man sit up and listen.

Now this attitude, I am perfectly aware, is likely to be resented by the scholarly mind. It is what is called "commercialism," and commercialism is supposed to be a very ignoble thing. If the attitude is studied, however, it may be discovered that it is not wholly unscientific.

The thing that impresses me most about scientists is that they are not so interested in what should be done as they are in what can be done. They do not care at all how electricity should act; they are simply curious to find out how it does act. They do not care what H_2O ought to be; they are anxious only to know what actually results when such a combination of gases occurs.

You would not permit a chemist to tell you that any formula should be adopted because the formula is socially important; hence, while I shall try my best to point out the social importance of adequate salaries in college and university research, I can not promise to separate the topic from the much more scientific theme of how salaries are raised.

You are doubtless familiar with the way in which educators got their living in the olden days. They attached themselves to lords and rulers and to wealthy patrons in a manner which, if you were to imitate it to-day, would lead to your being called a lot of grafters. They got their living in that way, however, because there was no other. They could not sell their philosophies to the poor, because in the first place the poor were altogether too overworked and tired to develop an appreciation for what the educator had to offer, and in the second place, the poor had no surplus with which to buy anything beyond their immediate physical necessities.

The great masses of people, it must be remembered, were always in poverty, although the masses created all the wealth. The accepted formula for becoming rich, in those days, was to take this wealth from the masses, generally through taxation; and he who was strong enough to wield the taxing power had the best chance of becoming wealthy.

It was a perfectly honorable proceeding. No one, not even the masses, questioned it. That it seems to us at this date to have been a very cruel order of society, and socially undesirable, is rather beside the point. It was the existing social order, and one had to live according to the laws governing that order or quit living. It was impossible, generally speaking, for people to support themselves and contribute much to the world's culture too. To secure a living through labor, one had to spend his whole time at it, and there was no time left for one to study and become a scholar. It was the mark of the scholar, then, that he was above soiling his hands with utilitarian toil, and the tradition has existed even to our times that the scholar is likely to be somewhat impractical.

But was the scholar ever impractical? Would it have been practical for him to spend his life in useful labor and thus make it impossible for him to attain any scholarship? The professors of old must have pondered that problem many times. They saw the injustices of the social order and many, like Plato, attempted to sketch an ideal human society. Saint Paul and the early apostles of Christianity, it is said, did try to support themselves by tent making and other handicrafts while they were carrying on their teachings, but unfortunately we have no record of how their economic scheme worked out. We know it was abandoned later, and the religious teachers of Christendom were supported by the church which, in turn, was generally supported by taxation.

In China, where the ancient patriarchal order endured right up to the present time, it was everywhere accepted that the scholar should do no work: and usually he grew finger-nails six inches long as a demonstration to whom it might concern that he would not and could not use his hands. Others, of course, had to work all the harder in order to free these scholarly gentlemen to develop their scholarship and their finger-nails. But those who worked did not resent it. The world, they seemed to have perceived, could not get along without education, and many a family whose members for generations were doomed to live out their lives in poverty and toil still imposed a voluntary tax upon themselves in order that some one member of their family every hundred years or so might become a scholar and thus bring honor to the family.

I do not wish to philosophize upon the theory or the traditions of education. I wish simply to point out that there was a good sound scientific reason for the tradition that the educator should be above the ordinary scramble for wealth. Never, however, was he or could he be aloof from the economic system. Unless there were leisure, there could be no education and culture; and those who specialized in education and culture were generally practical enough to abstain from practical affairs. The educators, whether they fully understood what they were doing or not, did adjust themselves to the existing economic order, and only when the economic order changed did the educational order change.

In the purely patriarchal order of society, before the days of cities and of wide-spread trade, about the only education which a child could get was that which he received within the family. It was about all he needed, for education consists, very largely at least, of an understanding and appreciation of one's relations to the things outside of himself; and in the family order, his family relationships and his relationship to his family's gods constituted about all the relationships which he could comprehend. People got almost their entire living from the land on which they squatted, and they did almost all their living then within that small community of squatters. If a child learned the full meaning, then, of father and mother and brothers and sisters, and if he learned how to do the things which it was necessary to do if the family was to be a going concern, he was properly accounted wise.

When trade began to develop, however, and families, instead of getting their whole living by applying their own labor to their own land, found it more advantageous to exchange a surplus in some line for some other family's surplus in another line, new human relationships were set up and a new education dawned. For, with the development of trade, there had to be trade routes and trade centers, and in these trade centers, people of very different traditions brushed up against each other and learned each other's traditions and each other's languages and each other's arts and handicrafts. They became sophisticated, and out of this sophistication the literature and the arts of the cities were evolved. There was no discernible evolution of the human brain, but there was a perceptible evolution of human understanding, calling for teachers of a decidedly new type. These teachers held aloof from trade, but they adapted themselves admirably to the economic and social structure which trade had built.

It was necessary that these far-flung trade routes have some traffic regulation. It was necessary that they be policed, if there was to be any semblance of order, and so the imperial state came into existence. This state required statesmanship—trained statesmanship—and presented a new field for educators, so education, again, had to follow the economic trend.

It was necessary, even, that the religions be revised. The old family gods, which had been perfectly adequate in a patriarchal society, would hardly do for an empire claiming dominion over the whole known world. Many attribute the rise of Christianity in the Roman empire to this need of the times for a god who wouldn't have to be carted around, but who could be depended upon to rule everywhere and take charge of every last detail of this highly complex world as the old Lares and Penates took charge of the ancient family affairs.

I am not a historian and do not know how far to accept the theory. It is obvious, however, that the rise of Christianity did not mean that all Europe had become suddenly converted to the idea of universal love. It is also obvious that the new religion was a state religion, and it remained everywhere a state religion until new economic forces began to assert themselves. It is worth noticing, moreover, that, wherever the state was the supreme economic power and the church and the state were looked upon as one, the church took charge of education, and out of the monasteries grew the universities.

With the coming of the first Industrial Revolution and the rise of what we know as "capitalism," education took a still different course. This course was made necessary by the new economic set-up, although few, if any, perceived the exact connection. This is not strange, for the capitalists did not think of capitalism as a new social order. They thought of it as a new way for individuals to get rich, providing the state and the nobility and the other traditional institutions would keep out of their way. The right of the individual loomed up as the controlling principle, and it was preposterous, people began to say, that one's status in life should be fixed by his birth or breeding. There was no conscious rebellion against the institution of the family. People expected to go on just as they had always gone on, excepting that one man would have equal rights before the law with any other; and wherever the new factory system became highly developed, there was a tendency toward democracy. The state was given charge of education, with the understanding that the state should be guided at all times by the consensus of the free and independent citizens.

Here was something of a predicament. It was bad enough, in the old days, when kings and ministers and ecclesiastic specialists assumed from time to time to tell the teachers just what they should teach. But now the theory was set up that the ignorant masses should stipulate just what and just how they should be taught. The theory, however, untenable as it may be, has died hard. The late Mr. Bryan gave voice to it when he argued that the taxpayers had a right to decide as to what is or is not correct biology.

Whether the taxpayers should or should not control education is, fortunately, a question which need not be discussed. For the point is, they can't. They may prohibit education. They make take measures to organize the school system so that the truth about things may be kept from the knowledge of the students. But they can not say what shall be taught. Much as they may try to do it, it can't be done, for the moment the schools set out to tell students what to think they cease to be an educational force in these modern times.

That statement needs examination, for the schools of the past surely did attempt to tell their students what to think—at least, many of them did, and they were still educational institutions. How does it happen that what was true once is no longer true?

You know the answer. What happened was modern science. After modern science got under way in human affairs, telling people what to think ceased to have the educational value which it had had before. For the world, up to this modern scientific era, had been governed by authority, that is, by the opinion of its rulers and its ruling classes. Class rule, in fact, was the only rule possible. If there was to be any culture, if there was to be any expansion of knowledge, if there was to be any human progress from generation to generation, it was necessary that the human mind and the human spirit be relieved, somehow, from the deadening influence of toil. It was necessary that there should be leisure, but it was impossible that there should be leisure for many, and if there were leisure for a few it could be attained only at the expense of putting upon the overburdened masses still heavier burdens yet.

Such an organization of society could not exist along with any theory of equality. There had to be special privileges, and the masses of people had to be taught to believe in the divine right of the privileged classes to exploit them, and only when the process was carried on to a humanly unendurable point was there ever much rebellion.

Capitalism ushered in modern democracy, not because the capitalists were philosophers who had reached the conclusion that special privileges were wrong, but because the special privileges of the landed aristocracy interfered with their individual schemes for getting rich. The capitalists did not consider themselves a class. Each capitalist was likely to look upon every other capitalist as his competitor, whom he would like very much to put out of business entirely. But he wanted to be free to do it, and only through exalting individual rights could he see that any free-for-all fight would be possible. The capitalist did not believe for a minute that his interests were the same as the interests of the masses. He did not believe that the interests of capital and labor were identical; he supposed, in fact, that it was to his interest to buy his labor in the cheapest possible market and that his best chance of success lay in the economic failure of his employees.

Moreover, the capitalists did not know that anything fundamental had happened to alter the age-old system of government by opinion. They did not understand what the dawn of modern science meant, and that man hereafter must live less and less according to the way in which he was told to live, and more and more according to the facts which it was possible for him to find.

They made no war against tradition, the only traditions to which they objected being those which stood in the way of their getting rich. In fact, those are about the only traditions which the world has ever rejected—those traditions which stand in the way of our economic interests. It is easier, generally, to accept a tradition than to think it through, and if people think that they can afford to accept it they will. Women, for instance, for thousands of years, obediently and complacently married the men whom their parents selected for them, because they couldn't afford to do otherwise; but women are very different creatures, now that they can afford to be.

I am not trying to give you an erudite account of the history of civilization. I am speaking, remember, purely as a business man. As a business man, I discovered that the so-called rules of business would not work. I discovered, to my cost at times, that the traditions of business were all out of plumb with its realities. I discovered particularly, as thousands of other American business men have been compelled to discover, that even my own opinions were not valid. We discovered, in the end, that business can not be run successfully on any one's opinion, but that, if we were to meet and beat competition, we would have to conduct our business upon actual scientific research.

This did not make me a scientist, but it compelled me to look into the matter of what science had been doing to human affairs. I had supposed, in my ignorance, that its main contribution had been the mere increase of knowledge—information which alert business men might make use of now and then. But I discovered that it was changing our whole approach to human life. It was not only breaking down certain traditions, but was arraying itself against all traditional thinking. It was making it increasingly impossible for class rule to go on and for human affairs to be determined by the opinion of some ruling class. Nor could the opinion of the majority be substituted, for when science made a discovery the discovery was not affected in the least by the election returns.

The old authorities, it seemed clear, were gone. The family, which had gained its authority through its economic dominance, was now losing its influence. Ecclesiasticism was also passing along with the whole theory of the divine right of minorities or majorities to tell us what to think. The truth, it was evident, no longer came from authority, but authority came only from the truth.

You are as familiar as I am with the change which has come over all human society since business began to shed its traditional opinions and adopted the methods of scientific research. No comparable change has ever happened in all human history in so short a time. But how this change affects the status of the teachers in our colleges and universities is the object of our special inquiry here. The traditions of education and the traditions of business may be as far apart as the poles, but the truths of education and the truths of business can not be contradictory. In the age of authority, of necessity I believe, educators had to effect some working alliance with the authorities. Doubtless they believed what they taught, and doubtless, also, the things that they taught were for the ultimate human good, however hard they might bear upon the masses in their generation. Educators in the ancient days could not proclaim liberty and equality and fraternity, for there was nothing in the economic set-up which made liberty and equality and fraternity possible. About the most they could do, then, in the way of alleviating the anguish of human life, was to teach the privileged classes to be just and merciful, and to give of their bounty to the poor. They may have felt themselves above economic considerations, but when education was necessarily confined to a small leisure class they could not be.

To be educated in the old days meant to be "well read," for the knowledge of the world was pretty well outlined in a number of books which it was possible for an exceptional mind to read and digest in a lifetime, if he had sufficient leisure to devote himself to the task. Hence it was quite natural, with the rise of democracy, that there be an attempt to make education universal so that everybody in the end might become well read. But those who were hoping along these lines failed to take note of what science had been doing. Science had been digging up new knowledge, and it had been digging up so much new knowledge that it had become impossible for any individual brain to absorb even the gist of it.

Little by little, then, the educators had to abandon the theory of a general education. Grudgingly, and with an agonizing tug at their traditions, they accepted specialization. One reason why they accepted it was that a knowledge of the ancient classics had struck a bear market, while there was an ever-growing demand for a knowledge of the new chemistry.

Weak opportunists in the educational field surrendered at once, and were quite willing, in return for fat endowments, to reorganize their colleges according to the new bourgeois demand. They admitted wealthy business men of no academic standing whatever to their directorates. These business men were supposed to be practical, but their course was such as to dismay the faithful old guard of college professors who were trying to live up to the best academic traditions and believed that education should be superior to money-making.

I hold no brief for either side. I am simply trying to state the situation. Unless the situation is understood, unless we can trace the forces which are reshaping human society and all its institutions, there is little likelihood of our solving the problem of college and university salaries. Those salaries are going up. I can say that confidently, and I can tell you why; but they will not go up rapidly enough, or in an orderly and systematic and satisfactory manner, unless the teachers themselves fully grasp the situation and deal constructively with it.

When business men began to control our institutions of higher education it might be supposed that they would alter them in accordance with the business needs of the day. But that is only a supposition based possibly on the supposition that, because a man had succeeded in business, he must know a great deal about business needs. There is little ground for this assumption, for until very recently, business was not governed by scientific fact-finding but by the opinion of the chief executive, and while this opinion was always affected by his business experience, it was almost uniformly grounded in tradition. If a man succeeded in business, then, it was not because he knew scientifically what he was doing, but because his opinion happened to be a little nearer the mark than the opinions of his competitors. But even if his opinions were good in the particular field to which his life had been devoted, this did not insure his having good opinions in other fields. If he had customarily asserted his good opinions strongly in his business, however, it was almost a foregone conclusion that he would assert his opinions quite as strongly elsewhere, whether he had any grounds for his opinions or not. This is a mere habit of human nature. It is part of the pompousness that comes from success.

But that type of business leader is going. He is going because business has discovered a safer and more efficient leadership—the leadership of scientific research. The great executive of to-day, when confronted with a business problem, does not give the answer to it. He *finds* the answer instead. He knows, of course, that he is unequipped personally to find these answers. They must be found by research specialists in scores of special lines; and every year, therefore, the demand is increasing for men and women trained in scientific thinking.

The great system of mass production which now dominates the market was developed by such thinking, and depends upon scientific research for its daily programs. And because it is dominating the market, all business must adopt its methods. In the very near future, then, there will be such a demand for fact-finders that our colleges and universities will be hard put to it to furnish an adequate supply, and those who are most capable of teaching and training our youth to become fact-finders will be tempted by large salaries away from the colleges and universities into business and industrial life.

I hope, when that time comes, that our teachers will prove to be sufficiently selfish. If they are unselfish, if they are willing to sacrifice themselves and their families to the *traditions of education and* go on teaching in college while their wives do the family washing, we may be in for considerable trouble; but if they are sufficiently selfish, as I have reason to believe they will be, it will be up to the colleges to find a way to keep them from accepting the offers which they get. And the only way that they can find will be through raising their salaries—not to a mere living wage but to several times beyond their present level.

And how will the colleges be able to do this? The answer is that they will do it by continuing the seemingly deplorable course upon which they started some time ago, making closer and closer connections with the business world.

But this time they will not be trading their academic ideals for fat endowments and elevating ignorant and opinionated business leaders to their directorates because they are rich. For the leaders of the new industrial order, while they may be ignorant, can not be opinionated. They must be men who are willing and eager to learn, who hold the positions they hold because they are eager and willing to learn, and who have at least learned one fundamental truth—that the best way to decide whether any course is right or wrong is to find out.

Schooled or unschooled, then, they will not wish to shape the colleges to their preconceived opinions. They will put them, if they can, upon a fact-finding basis; and when it is discovered that the colleges are losing their best men because they are not being adequately paid, the answer to that will be adequate salaries.

It may seem to some that I am suggesting an unconditional surrender of educational ideals to the economic necessities of the moment. I am not. But the problem, I wish to emphasize, is not one of whether education shall remain aloof from economic change or be guided by it, for education can not remain aloof from economic change: it is impossible that education shall develop in one direction while human relations are developing in another. The problem for the teachers, as I see it, is whether they shall accept the facts of economic change, in the same way that they accept the facts of chemistry and physics, and organize their understanding and their activities in accordance with those facts, or whether they shall be driven blindly into positions which seem to be at variance with their academic ideals.

For I am not talking about what ought to happen. I am talking about what is happening now and what, because of forces which are so actively at work among us, must happen more and more.

Thousands of teachers to-day, especially in our larger cities, are eking out their salaries with part-time commercial employment. Many of them resent the necessity for this. They would rather, they think, be liberated to teach pure truth, than have to go into the world of business and discover from day to day what the pure truth about that world is. I can sympathize somewhat with their resentment; nevertheless, it is one of the best signs of our times that the teachers of our youth all over the country are getting this practical first-hand knowledge and keeping the educational and the business orders within communicating distance. If they are not kept within communicating distance, we know, one or the other must soon fade out of the picture, and it will not be the economic order that will go. Every such tie-up, then, is of direct practical value to the colleges and universities. If there are seeming clashes between the truths of education and the truths of business, it will do no good for educators and business men to try to argue it out. Educators know this, and business men, I am glad to say, are beginning to know it. They are beginning to know that, when problems arise, the only dependable course is to discover the facts.

What is most necessary now is that this unconscious and disorderly movement to blend education and industry become conscious and orderly. The schools must perceive the necessity of fusing with our new economic order, and our industrial civilization must perceive the necessity of building up, within itself, a genuine educational and cultural life.

Teachers, then, of all people, must of necessity learn the facts of our changing economic order; and when those facts are learned, I feel very certain much of the resentment against "commercialism" will disappear.

For this machine civilization is not at all what its very leaders have traditionally supposed it was. It is not the creation of supermen or of business geniuses. It is a simple matter of science and power coming into very ordinary human brains and hands. Science discovered the power. Ignorance has used it, to be sure, to our individual and social undoing, but the great historical event of our times is that it has been discovered that this power can not be successfully used in anything less than the scientific way and that the scientific way to use it has proved to be the way of maximum service and maximum total profits.

When man began to use it, he supposed that he could use it at the expense of others. Now, not because he has had a change of heart, he is beginning to learn that this can not be done. Time was when men could get rich in business through exploiting their fellow men on every hand. Some may seem to be doing that to-day, but the game is almost played out, for the markets of the world are fast becoming dominated by those industrial and commercial institutions which are scientifically discovering how to give more service for the money than has ever been given before.

Time was, not so long ago, when high prices were supposed to mean large profits. There was a reason for such a belief, for it was universally perceived, before power came into the world, that the masses of people could not possibly buy the beautiful and luxurious things with which business most concerned itself.

But mass production has changed all that. Mass production means production for the masses. Unless the masses can buy, mass production, with all its economies, can not go on. Therefore, mass production, which already dominates our markets, insists—for scientific rather than sentimental reasons—that the masses be equipped with buying power, and by the use of science in methods and in management has discovered how production may be so increased per man that these higher wages may be paid.

The ancient theory of business was to add a profit to the cost of production, however great the cost of production was, and search for the few customers with sufficient buying power to pay such a price. The new principle is to set a price which the masses can pay, and then to enlist all the available science in the world to discover how the thing may be produced and sold at a profit within that price.

This second Industrial Revolution is the greatest revolution in human history. All previous revolutions meant the ascendancy of some new class over the previous ruling class. This revolution means the ascendancy of science and the liberation of the masses, not merely from the tyranny of some ruling class, but from the devastating influences of poverty and toil. I grant that the masses are still ignorant, and that universal literacy has not meant, and could not mean, universal education. Even if it were possible for all to read the classics and to recite them glibly in the original Latin and Greek, still there would not be universal education. For education consists, largely at least, of an understanding and appreciation of our relation to the things outside ourselves, and the ancient classical curriculum can not give us that. Only as we learn the truth, including the truth about life as it is and as it is becoming, will the truth make us free to live a larger life.

The machine civilization not only needs this truth but is rapidly becoming conscious of the need. Business needs fact-finders, and is employing them more and more. Also it needs fact-finders with adequate equipment and adequate buying power. And it needs fact-finders not only in the realm of chemistry and physics but in every science which points a way to a larger human life.

Business in the near future must come to realize that it needs psychologists quite as definitely as it needs engineers, and sociologists quite as much as economists. Not only must business be freed from traditional thinking, if it is to meet the scientific competition of to-day, but the masses whom it serves must be freed from traditional thinking if they are to function adequately in this new world order.

This new economic system can not afford war, and it can not afford the narrowness and provincialism which engender it. It can not afford ugliness, or that deadening contentment which the ruling classes once insisted that the masses should cultivate. As leisure increases and buying power increases, there must be a corresponding increase in ambition for and appreciation of the good things of life. Taste and culture then must be developed. The emotions must be educated and there must be a greater and greater development of the spiritual values as this supposedly materialistic machine civilization goes on to its logical destiny.

I have said often, to business audiences, that the pursuit of beauty is the greatest thing in human life. It always was the greatest thing, but now we have hit upon times when the masses of humanity everywhere can and must engage in that pursuit. The pursuit, however, must be along fact-finding lines. The new order can not be discovered in the old traditions. It must be discovered in the new relationships, and the time of the discovery will depend very largely upon the willingness of our educators to break from the old tradition of aloofness and enter into joyous, whole-hearted, enthusiastic and constructive cooperation with this new, fact-finding, economic system.

If this be commercialism, make the most of it.

DISCUSSION

A writer in *Science Progress*[1] some years ago expressed the opinion that the pretense that the man of science is above cash in any form is perhaps the worst form of scientific snobbery. "In science as in other things," said this writer, "the proper and honest procedure is to pay for work done." This form of scientific snobbery, now rapidly and most fortunately disappearing, did not fool the clear-headed among business men. The late E. W. Scripps, one of the founders of the Scripps chain of newspapers and of *Science Service*, regarded scientists who willingly and unnecessarily labored on a miserable stipend as economic imbeciles. A biologist might have said that such scientists were not well adapted to their environment. Adaptation is likely to be the key to survival of scientists as well as other organisms.

It is common knowledge that scientific research in a single century has outstripped the experience of ages. Dr. Cattell is authority for the statement that science has increased wealth fourfold, an assertion very easy to believe. The same leader points out that democracy is dependent on science.

The "fiat currency of honor and position" does not pay the bills, even for personal and official scientific advancement. Peixotto's studies at California indicate that the average expenditure of ninety-six faculty men for professional advancement was only 1.3 per cent. of salary, and twenty-two of them spent less than one half of one per cent. Henderson in a similar study at Yale found that two thirds of the faculty had to supplement their regular university salary by outside work, and that in some instances the professors could not even afford to send their children to a college of the grade in which they themselves were teaching.

It is perhaps unfortunate that the world does not "seek out its benefactors and voluntarily offer them the reward to which they are entitled." Breuer[2] rightly says, "The physician's primary duty is to provide a comfortable existence for himself and his dependents. That comes even before his duty to his fellow man for the simple reason that he can not do his fellow man much real good unless he is properly equipped."

According to Professor Compton there was in 1927 no university in America, land of wealth and opportunity, which was able to offer, dollar for dollar, a salary equal to salaries in universities even in war-ridden Germany.

J. S. Ames, now president of the Johns Hopkins University, asserted,[3] "The scientific men of America have suffered greatly at the hands of the people." The significant statistics presented by Professor Noyes at the symposium on the salary question, arranged by the Committee of One Hundred on Scientific Research of the American Association for the Advancement of Science at Des Moines, Iowa, December 31, 1929, amply substantiate President Ames' statement. To quote Ames further: "The time has come for America to recognize the usefulness of the scholar, the thinker, the investigator of science. All the other countries of the world have done so long since."

Science[4] quotes the British Committee of the Privy Council for Scientific and Industrial Research to the effect that all the important advances which recent generations have made in industrial science, from wireless telegraphy to synthetic indigo, have been the direct outcome of discoveries made by "pure" science conducting research solely for its own sake. The committee also emphasizes the necessity for a let-up on competition, and for more cooperation, and concludes that "it is not an accident that the firms which have been most conspicuous in the world for their scientific advances—such as the Carl Zeiss firm of Jena—have also been most conspicuous for enlightened and generous conditions of employment."

The importance of science to civilization requires that intellectual ability of the highest order should be recruited, developed and devoted to research—ability certainly equal or superior to that of the foremost captains of industry. The experience and testimony of our leaders indicate unequivocally that there is a high degree of correlation between salaries and standards of performance.

In 1926 Professor William MacDonald said, "We might have had the needed endowments long ago if intellectual workers, recognizing their solidarity, had unitedly asked for them; we can have them now whenever the workers are prepared to use them and ask for them with common voice."

There used to be an idea among some scientists, now happily dissipating, that organization for economic advancement would hamper individuality, would tend to mediocrity of performance. The accumulating experience of actors, physicians, professors, lawyers and engineers unmistakably indicates that this is not the case. On the contrary, organization, by providing the benefits of contact, united effort, more adequate salaries, superior facilities for work and improved status, gives freer play to the expression of individual abilities and tends to strengthen all inventive and investigative efforts.

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[1] Quoted in Science, May 4, 1917, pp. 433–435.

[2] *Medical Economics*, April, 1924, pp. 17–19.

[3] Science, October 5, 1918, pp. 401–410.

[4] November 3, 1916, pp. 641–642.

Scientific men are working together increasingly along economic lines, not to control anything or anybody, but to secure that status which will enable research men to do their best for society.

The Committee of One Hundred on Scientific Research of the American Association for the Advancement of Science is doing a notable service to all scientific men and to the community. Special credit is due to President Millikan, and to Messrs. Cattell, Kellogg, Pupin, Livingston and True, members of the Executive Committee of the Committee of One Hundred. The efforts of the council and the Executive Committee of the association in supporting the work of this committee also deserve appreciation. Most of the work of the Committee of One Hundred has fallen on Dr. Rodney H. True, head of the department of botany and director of the Botanic Garden at the University of Pennsylvania, whose tireless efforts as secretary of the committee are well known to those who have worked close to him.

The work of the Committee of One Hundred has been done in the spirit of a statement made by Sir John Russell referring to research in agriculture:

> The past has been rich in the joys and thrills of discovery; but it has taught this lesson: that discoveries in applied science inevitably follow advances in pure science. If we would improve our agriculture the surest way is to increase knowledge of the soil, the plant and the animal. Empirical methods, it is true, have often given advances in the past, but they are slow, hesitant and uncertain; dependent on accident. *Exact knowledge* is the only sure basis for improvements; encourage, therefore, those among you who are striving to win it.

WALTER P. TAYLOR

NATIONAL FEDERATION OF
FEDERAL EMPLOYEES

OBITUARY

RECENT DEATHS

DR. WILLIAM E. STORY, professor of mathematics at Clark University from its foundation in 1889 to 1921, and since then professor emeritus, died on April 11. He would have been eighty years old on April 29.

DR. FRANK HAIMBACH, assistant curator of entomology at the Academy of Natural Sciences, Philadelphia, has died at the age of seventy years.

DR. FRANZ C. WALDECKER, director of chemical research at the Winthrop Chemical Company, Inc., and the H. A. Metz Laboratories, Inc., died recently in London. He was forty-eight years old.

PROFESSOR JOHN OLIVER ARNOLD, F.R.S., emeritus professor of metallurgy in the University of Sheffield, died on March 27 in his seventy-third year. He was a pioneer in work on vanadium and molybdenum.

THE death at the age of sixty-four years is announced of Professor R. Zsigmondy, holder of the Nobel prize for 1926, professor of chemistry at the University of Göttingen.

THE death is announced of Dr. Hermann von Ihering, professor of zoology in the University of Giessen.

DR. KATSUSABURO YAMAGIWA, professor of pathology at the Tokyo Imperial University, Japan, died on March 2. He specialized in the experimental study of cancer. The production of tar cancer in rabbits was one of his outstanding accomplishments.

MEMORIALS

A TABLET in memory of Bashford Dean was unveiled on April 14 in the hall of armor at the Metropolitan Museum of Art. The tablet is the gift of the sculptor Daniel Chester French. Dr. Dean was at the time of his death honorary curator of arms and armor at the Metropolitan Museum as well as honorary curator in the American Museum of Natural History and professor of zoology at Columbia University.

THE *Journal* of the American Medical Association reports that the physicians at Fukushima, the native place of the late Dr. Hideyo Noguchi, have erected in his honor a stone monument in the garden of his old house on Lake Inawashiro, and the house has been bought to be kept forever in his memory. A library will be established near the house.

The British Medical Journal writes editorially: "Jean Baptiste Lamarck, soldier, biologist and philosopher, was born in Picardy in 1744, and died in 1829. His remains lie buried in an anonymous grave in Montparnasse cemetery, Paris, but until 1914 his native country had a memorial of him in the house where he was born, the home of his ancestors at Bazentin, a small village of the Somme, not far from Albert. During the war years Bazentin lay within the war zone, and now what was Lamarck's house is but a heap of ruins. The Société Linnéenne du Nord de la France has resolved to raise a fund to be used for the purpose of erecting on the site of the old house a memorial worthy of Lamarck's greatness. This memorial will stand in the middle of a garden in which the plants grown will be the botanical species specially studied by Lamarck, or named after him by other botanists. Lamarck belongs not only to his own province and country, but to all countries whose culture has been influenced by his pioneer work; and the society feels, therefore, that to help it in its project it may call on the members of the great scientific brotherhood throughout the world. It extends its appeal to the scientific societies of the British Isles, and asks that all remittances by check or international postal order should be directed to the account of the Société Linnéenne at the Banque de France, succursale d'Amiens (Somme), and ear-marked for the Lamarck Fund. Letters should be sent to M. le Secrétaire Général du Comité Lamarck, 81, rue Lemerchier à Amiens, Somme."

SCIENTIFIC EVENTS

GIFT OF CRYSTAL TO THE SMITHSONIAN INSTITUTION AS A MEMORIAL TO WORCESTER REED WARNER

The Smithsonian Institution announces that a perfect sphere of flawless crystal, believed to be the largest in the world, is now the property of the United States National Museum, thanks to the generosity of Mrs. Worcester Reed Warner. Mrs. Warner made the gift as a memorial to her late husband, whose own outstanding achievements were largely in the manufacture of astronomical instruments from quartz.

The crystal ball measures 12⅞ inches in diameter and weighs 106¾ pounds. Perfect spheres of as much as 6 inches in diameter are great rarities, prized alike by emperors and museums, so that the uniqueness of the National Museum's acquisition may be realized.

The block of quartz from which the ball was cut is said to have come from Burma and must have weighed over 1,000 pounds. It was cut in China and polished in Japan. Eighteen months were required for this delicate and laborious task. According to Mr. George F. Kunz, the Japanese workmen first round the rough mass of crystal by careful chipping with a small steel hammer, forming a perfect sphere with the aid of this tool alone. For grinding they use cylindrical pieces of cast iron, about a foot in length and full of perforations, in which the ball is kept constantly turning. The abrasive material used in this first grinding is powdered emery and garnet. The final polishing is effected with crocus or rouge (finely divided hematite), giving a splendid lustrous surface.

The ball came to this country in 1925 and was immediately placed on temporary deposit in the National Museum. The officials of that institution express their pleasure that Mrs. Warner's gift makes it the permanent property of the nation. The late Mr. Warner, to whom the gift is a memorial, was a member of the firm of Warner and Swasey, instrument makers. Mr. Warner designed and constructed three of the largest telescopes in use in this hemisphere, including the 36-inch instrument of the Lick Observatory, the 40-inch telescope of the Yerkes Observatory and the 72-inch telescope for the Dominion of Canada.

FELLOWSHIPS IN CHEMISTRY AT THE JOHNS HOPKINS UNIVERSITY

The Department of Chemistry of the Johns Hopkins University has announced the second annual quota of fellows selected under the National Fellowship Plan established last year. The plan provides ultimately for the establishment of one fellowship from each of the forty-eight states of the union. There are in addition two national fellowships-at-large and one international fellowship for England.

In announcing the names of the newly elected fellows, Dr. J. C. W. Frazer asked that it again be *emphasized that the chemical fellowship plan at the* Johns Hopkins University does not contemplate the discovery of chemical geniuses nor the production of "super-chemists." "The plan is in effect," he said, "an experiment in chemical education which puts into actual operation a few ideas which are almost universally endorsed but too seldom concretely applied. The unique feature of the situation is that careful planning on the part of the university officials and generous cooperation from public-spirited individuals and organizations have made it possible to remove many of the practical difficulties which often stand in the way of 'ideal' procedure."

The fellows newly selected by the respective state *committees are as follows:*

William Shallcross Speed Fellowship: Thomas Cross, Jr., University of Kentucky, Lexington.

U. S. Industrial Alcohol Co. Fellowship: Donald L. Zink, Louisiana State University, Baton Rouge.

General Motors Corporation Research Laboratories Fellowship: Arthur L. Glasebrook, University of Michigan, Ann Arbor.

Hormel Foundation Fellowship: Walter O. Lundberg, University of Minnesota, Minneapolis.

G. A. Pfeiffer Fellowship: Lloyd B. Thomas, University of Missouri, Columbia.

John M. Hancock Fellowship: Donald L. Farnham, University of North Dakota, Grand Forks.

John Wiley and Sons, Incorporated, Fellowship: Donald A. Wilson, Geneva College, Beaver Falls, Pennsylvania.

Du Pont Fellowship: Clarence P. Ely, University of Richmond, Virginia.

Fleischmann Fellowship: William Redmond Johnston, University of Washington, Seattle.

Carbide and Carbon Chemicals Corporation Fellowship: Henry C. Chitwood, West Virginia University, Morgantown.

Patrick Garvan Memorial Fellowship-at-large: Theodore L. Brownyard, Massachusetts Institute of Technology, Cambridge.

The English fellowship will not be awarded until later in the year.

Each fellow receives one thousand dollars annually while studying for his degree at the Johns Hopkins University.

The course of instruction outlined for them emphasizes fundamental training in mathematics, physics and English, as well as in the four major branches of chemistry (inorganic, organic, physical and analytical). A broad fundamental training is the objective.

The plan also provides for contact with prominent chemists, both American and foreign, under a special lectureship established by Dr. A. R. L. Dohme, of Sharpe and Dohme.

To date twenty-five fellowships have been established. They are as follows:

Eli Lilly Company, Indianapolis, Indiana.
Firestone Tire and Rubber Company, Akron, Ohio.
Francis P. Garvan, given at-large.
J. T. Baker Chemical Company, Phillipsburg, New Jersey.
H. A. B. Dunning, Baltimore, Maryland.
The Bill Raskob Foundation, Wilmington, Delaware.
The Brown Company, Berlin, New Hampshire.
The Brown Company, Portland, Maine.
The Kewaunee Manufacturing Company, Kewaunee, Wisconsin.
The General Motors Corporation Research Laboratories, Detroit, Michigan.
The Carbide and Carbon Chemicals Corporation, West Virginia.
The Fleischmann Company, Washington.
William Shallcross Speed, Louisville, Kentucky.
Patrick Garvan, given at-large.
Mary Carroll Garvan, given at-large.
John Wiley and Sons, Incorporated, Pennsylvania.
U. S. Industrial Alcohol Company, Louisiana.
Hormel Foundation, Austin, Minnesota.
E. I. du Pont de Nemours & Company, Virginia.
John M. Hancock, North Dakota.
Frederick G. Donnan, England.
G. A. Pfeiffer, Missouri.
American Can Company, California.
American Can Company, Oregon.
American Can Company, Utah.

SUMMER MEETING OF THE BOTANICAL SOCIETY OF AMERICA

The informal summer meetings held last summer at Dartmouth College, Hanover, New Hampshire, and at the University of Wyoming, at Laramie, Wyoming, met with such warm appreciation by those who were present that the society decided at its last meeting to arrange for one or more such meetings for the coming summer. Preliminary inquiries developed the fact that a large number of botanists will be in England and elsewhere and it seemed best in view of this wholesale migration to hold but one meeting. It seemed that this might be a good time to accept the cordial invitation from the University of Washington, Seattle, to meet at the Biological Station of that university, Friday Harbor, on Puget Sound.

Here exceptional opportunities will be offered for observing the giant algae of the Pacific and the otherwise rich vegetation of the Sound. Proximity to lumbering operations as carried on among the large trees of the northwest as well as to glaciers on Mt. Rainier or Mt. Baker offers other interesting possibilities.

Round-table talks as general subjects and impromptu discussions as personal associations may suggest will give the same informality to the meeting that characterized those of last year.

A hearty welcome will meet all botanists whether members of the society or not. Colleagues from other countries are cordially invited to be present.

A circular giving more detailed information will be mailed to members of the society in May.

Meanwhile, inquiries may be addressed to Professor T. C. Frye, Botanical Department, University of Washington, Seattle, Washington.

Rodney H. True,
Chairman of the Organizing Committee

CELEBRATION IN HONOR OF DR. WELCH

A distinguished audience gathered in Memorial Continental Hall, Washington, D. C., on April 8, to celebrate the eightieth birthday of Dr. William H. Welch, professor of the history of medicine at the Johns Hopkins University.

The address made by President Hoover was transmitted by international radio and meetings had been arranged in many American and foreign cities. The program included speeches by the President; Dr. Livingston Farrand, president of Cornell University, and Dr. Simon Flexner, director of the Rockefeller Institute for Medical Research; reading of congratulatory messages by John A. Kingsbury, of the Milbank Memorial Fund, and the presentation of the first impression of a dry-point etching of Dr. Welch by Alfred Hutty.

President Hoover's address was as follows:

> The many years that I have been honored with Dr. Welch's friendship make it a privilege to join in this day of tribute to him by his friends, and by the great scientific societies of our country and the whole world.

Dr. Welch has reached his eightieth year, and a whole nation joins in good wishes to him.

Dr. Welch is our greatest statesman in the field of public health, and his public service to the nation well warrants our appreciation of him. With profound knowledge, wide experience and skill in dealing with men, sound judgment and a vision of the future, he has been a great asset to the nation, and we may fortunately hope that he will continue for many years more to bless mankind with his invaluable leadership.

Our age is marked by two tendencies, the democratic and the scientific. In Dr. Welch and his work we find expression of the best in both tendencies. He not only represents the spirit of pure science, but constantly sees and seizes opportunities to direct its results into service of human kind.

Medicine until modern times was a species of dramatic play upon emotions rather than a science made useful through technology. It combined centuries of experience in trial and error in reactions from many drugs, with a maximum of skill on the part of the practitioner in a kindly art of making the patient feel as hopeful and comfortable as possible while he was dying of the disease, the origin and treatment of which were as yet undiscovered. Providence was made responsible for his fate, rather than the bacillus which should never have been allowed to infect him.

Modern medical practice, however, is based upon a vast background of scientific research and discovery. In the creation of this science, in the conversion of its principles into technical methods for use in actual practice, in the diffusion of knowledge of these principles and methods and in the application of them upon a national and world-wide scale, Dr. Welch has played the leading American part.

As a research worker in pure science he has made original and valuable discoveries. As a technologist he has devised practical methods of applying pure science. As a teacher he has spread true knowledge and inspiration among thousands and hundreds of thousands. But in organizing and directing research and application of medical knowledge on a wider field of prevention of disease, he is among the preeminent few who deserve the title of statesman.

No valuable change in everyday practice of any of the great arts has ever been made that was not preceded by the accretion of basic truths through ardent and painstaking research. This sequence that precedes effective action in medicine is equally important in every field of progress in the modern world. It is not the method of stirred public emotions, with its drama of headlines; it is rather the quiet, patient, powerful and sure method of nature herself, of which Dr. Welch is the master.

Dr. Welch has happily combined in his character and intellect the love of truth and the patient experimental habit of the pure scientist, with the ingenuity of the inventor and the organizing vision and energy of the promoter of sound enterprise—and combines all these things with a worldly wisdom and gracious charm that have made him a leader among men.

I know that I express the affection of our countrymen and the esteem of his profession in every country when I convey to him their wishes for many years of continued happiness.

SCIENTIFIC NOTES AND NEWS

At the banquet in Washington on April 8 celebrating the fiftieth anniversary of the American Society of Mechanical Engineers, President Hoover was presented with the first Hoover Gold Medal, founded "to commemorate the civic and humanitarian achievements of Herbert Hoover," and to be awarded hereafter for distinguished public service by engineers. The presentation was made by Dean Dexter S. Kimball, president of the board of award and past president of the society. The ceremony opened the exercises, which were presided over by Professor William F. Durand, past president, as toastmaster. Charles Piez, president, made an address on "The Broadening Responsibilities of the Engineer" and Dr. Robert A. Millikan followed, speaking on "The Bonds between Science and Engineering."

The Founders' Medals of the society were presented at a luncheon at the Mayflower Hotel. Acting as honorary chairman was Ambrose Swasey, one of the six survivors of the founders of the society and a past president. John R. Freeman, also, past president, presided. Those honored besides Mr. Swasey were: John W. Cloud, of London; John S. Coon, Atlanta, Georgia; Robert Grimshaw and Francis H. Richards, of New York, and E. H. Robbins, of Pittsfield, Massachusetts.

Gold and silver medals constituting the Rumford Premium of the American Academy of Arts and Sciences were presented on April 9 to Dr. John S. Plaskett, director of the Dominion Astrophysical Observatory, Victoria, B. C., in recognition of his researches on stellar spectroscopy. On the occasion of the award of these medals Dr. Plaskett addressed the academy on "The Gases of Interstellar Space."

Dr. William Elgin Wickenden was inaugurated as president of the Case School of Applied Science on April 11. Delegates from 48 research and national scientific bodies and from 115 colleges and universities attended. Dr. Dexter S. Kimball, dean of engineering, Cornell University, spoke for engineering, and Dr. Charles G. Abbot, secretary of the Smithsonian Institution, for science. Frank A. Quail, president of the board of trustees, delivered the opening address.

Dr. Irving Langmuir, director of the Research Laboratory of the General Electric Company at Schenectady, addressed an audience of German scientific men, in Berlin, including Professor Albert Einstein, on March 11, on "The Chemical and Electrical Properties of Absorbed Films on Tungsten."

Dr. Felix W. Pawlowski, Guggenheim professor of aeronautics in the college of engineering of the University of Michigan, has recently been elected a fellow of the Royal Aeronautical Society of England.

The William Mackenzie Medal for 1929 for original contributions to ophthalmology has been awarded by the Glasgow Eye Infirmary to Professor Dr. van der Hoeve, of Leyden, Holland.

Vice-Admiral Sir Robert Dixon, president of the Institute of Marine Engineers, and Dr. H. J. Weld, organizer of the Weld-Ashmolean Expedition to Kish, have been elected members of the Athenaeum Club, under the provision that empowers the election of persons of distinguished eminence in science.

The honorary membership of the Academy of Sciences of Finland has been conferred on Sir J. C. Bose for his contributions in advancement of knowledge of life-reactions in plants.

At a reception held at the Egyptian Legation in London on March 12 the chargé d'affaires, Dr. Hamed Mahmud, presented to Lord Moynihan, of Leeds, president of the Royal College of Surgeons, the Grand Cordon of the Order of the Nile, bestowed on him by King Fuad.

Rear-Admiral Andrew T. Long, of the United States Navy, received sixty-one votes in an election for a successor as head of the International Hydrographic Bureau to Rear-Admiral Albert P. Niblick, United States Navy, who died last year. Seventy votes are necessary for election. Captain Mares, of Great Britain, had forty-six votes; Captain Speiss, of Germany, twenty, and Captain Laujauns, of Holland, eight.

Dr. James Bryant Conant, professor of organic chemistry of Harvard University, has been elected a member of the board of scientific directors of the Rockefeller Institute for Medical Research.

Professor Joseph B. Shaw, head of the department of ceramics in the School of Mineral Industries at the Pennsylvania State College, has been selected by the Bangor Association of Slate Manufacturers as its representative to work with the Bureau of Standards in fixing standards and devising tests to insure uniform grades of roofing slate for government use.

E. M. Mervine, professor of agricultural engineering at Iowa State College, has resigned in order to enter the service of the U. S. Department of Agriculture. As agricultural engineer he will devote his time to the investigation and development of sugar-beet machinery.

Gilbert L. Stout, who since 1926 has been field botanist for the Illinois State Natural History Survey with headquarters at the University of Illinois, has taken a position as plant pathologist with the California State Department of Agriculture at Sacramento.

Dr. Lyman F. Kebler, for many years government specialist in drugs and medicines, dealing with the enforcement of food, drug and mail-order laws, is reported by the *Journal* of the Washington Academy of Sciences to have been made medical director of the Tennessee Products Corporation at Nashville, where his work will include assistance in the utilization of by-products, medicinally and otherwise, as well as health matters connected with the corporation's activities. Dr. Kebler will continue to be medical director of the John McEntee Bowman health interests, identified with the Biltmore chain of hotels, and in addition to his general headquarters in Washington, D. C., will have offices in Nashville and in New York City.

Dr. Howard B. Stough has been promoted to the professorship of zoology and has been made head of the department at the University of Idaho.

Dr. Charles Christian Johnson, instructor in pharmacology at the Stanford University School of Medicine, has been appointed professor of pharmacology in the School of Medicine of the University of Utah.

Dr. Harvey J. Howard, professor of ophthalmology at Washington University, Saint Louis, announces the following appointments in the department: Dr. George H. Bishop, now associate professor of physiology in the School of Medicine, professor of applied physiology; Dr. Louis A. Julianelle, of the Rockefeller Institute for Medical Research, associate professor of applied bacteriology and immunology; Dr. James A. Hawkins, also of the Rockefeller Institute, associate professor of applied biochemistry; Dr. R. Wendell Harrison, of the University of Chicago, instructor in applied bacteriology and immunology, and Mr. Garvey Bowers, of the University of Kansas, research assistant in applied bacteriology.

Nature reports that in connection with the Physical and Chemical Survey of the National Coal Resources, which is one of the aspects of the fuel research work of the Department of Scientific and Industrial Research, the department has recently appointed a committee to deal with the West Yorkshire Coal Area. Among the members are: Professor J.

W. Cobb, Leeds; Professor J. A. S. Ritson, Leeds; Mr. C. E. N. Bromehead, Geological Survey of Great Britain; Dr. C. H. Lander, director of Fuel Research, and Dr. F. S. Sinnatt, superintendent of the Coal Survey. The object of the survey is to investigate the characteristics of the various coal seams in Great Britain with the view of their utilization to the best advantage. Local laboratories are established in each area for the examination of samples, and, when necessary, large-scale investigations are carried out at the Fuel Research Station (East Greenwich) or elsewhere.

Dr. C. O. Swanson, head of the department of milling industry at the Kansas State Agricultural College at Manhattan, has been granted leave of absence from May 1 to September 30 to enable him to make a study for the U. S. Department of Agriculture of the utilization of American wheat in Europe.

Dr. Thomas R. Garth, professor of educational psychology in the University of Denver, is conducting researches on the color blindness of Indians, starting at Santa Fé, New Mexico.

Walter Granger, paleontologist and second in command of the Central Asiatic Expedition of the American Museum of Natural History, and Albert Thompson, assistant paleontologist, sail from Seattle on April 18 for Peking, where they will join Dr. Roy Chapman Andrews on the fifth and final trip of the expedition into the Gobi Desert.

Dr. Robert A. Millikan gave an address on April 10 in the engineering auditorium, New York City, on "Recent Advances in Our Knowledge of the Universe around Us," under the auspices of the American Institute of the City of New York, the Museums of the Peaceful Arts and the New York Electrical Society.

Dr. Chas. B. Davenport, director, department of genetics of the Carnegie Institution of Washington, at Cold Spring Harbor, L. I., delivered an address on "The Mechanism of Organic Evolution" before the Washington Academy of Sciences on April 16.

Dr. Wilder Dwight Bancroft, professor of chemistry at Cornell University, is to give the dedicatory address on "Modern Science" when the Hall of Science of the University of Southern California, the final wing of which has recently been completed, is formally dedicated on June 6, during the one-week semi-centennial celebration.

Dr. Joseph Erlanger, professor of physiology in the Medical College of Washington University, St. Louis, will deliver the Hitchcock lectures at the University of California, beginning on April 21. The general subject of the lectures is "The Analysis of the Electrical Manifestations of Nerve Action."

The first course of lectures under the Porter Lectureship in Medicine of the University of Kansas School of Medicine was delivered on April 1 and 2 at the Bell Memorial Hospital by Dr. Lewellys F. Barker, emeritus professor of medicine, Johns Hopkins University. The subjects of the lectures were "Diagnosis and Treatment of the Commoner Personality Disorders" and "Psychology and Medicine."

Dr. A. J. Carlson, professor of physiology at the University of Chicago, lectured to the students and faculty of the Vanderbilt University School of Medicine on March 31. His subject was "Organotherapy." The lecture was given under the auspices of the Phi Beta Pi fraternity.

Walter A. RuKeyser, who has recently returned from a five months' trip in Russia, where he served as technical adviser to Uralasbest, the state absestos trust, gave recently a lecture before the department of geology of Princeton University on "The Consulting Engineer in the Union of Socialist Soviet Republics."

Dr. Victor M. Goldschmidt, professor of mineralogy and crystallography at the University of Göttingen, gave in March lectures on chemical geology at the University of London.

The Experiment Station Record calls attention to the Ninth International Horticultural Congress which will meet in London from August 7 to 15 under the auspices of the International Committee for Horticultural Congresses and by invitation of the Royal Horticultural Society. Addresses are scheduled for three days and will be divided into three main groups of propagation, pomology, botanical gardens and general subjects. The remainder of the time will be largely devoted to excursions to private and commercial gardens, nurseries and similar establishments, the gardens of the Royal Horticultural Society and the Royal Botanic Gardens at Kew, the Rothamsted Experimental Station and the research stations at East Malling, Cheshunt and Long Ashton, and the John Innes Horticultural Institution. There will also be a special horticultural exhibition on August 14 and 15.

An international league for combating trachoma was founded at the thirteenth International Ophthalmological Congress. The president of the league, Professor Emile de Grósz, and the secretary, Dr. F. Wibaut, were entrusted with the formation of a committee composed of delegates from the various national ophthalmological societies. Up to the end of February forty-nine delegates had been nominated from twenty-six countries. The next meeting of the league will be held on July 26 in Geneva, and the program will be issued at the close of May.

An institute of natural sciences will be held at Bowdoin College early in 1931. This will be the fifth institute in the series begun in 1923, the first four having covered the fields of modern history, literature, the fine arts and the social sciences.

The Twenty-fourth Annual Convention of the Illuminating Engineering Society is to be held in Richmond, Virginia, from October 7 to 10. Present plans contemplate sessions to be devoted to lighting practice, natural lighting, lighting service, ultra-violet radiation, lighting education, light in architecture and decoration, as well as the usual business sessions on the opening day. The committee on lighting service is also planning to hold a pre-convention meeting on the day immediately preceding the opening of the convention, which will be devoted entirely to subjects of interest to central-station lighting service engineers. This will be held on October 6.

Sigma Pi Sigma, honorary physics fraternity, has granted petitions for charters at the University of Washington, Park College and William Jewell College. Chapters at these institutions will be installed about the middle of May in connection with the installation of several other chapters at institutions where petitions are now under consideration.

An Associated Press Dispatch reports that the Massachusetts General Hospital, the Boston Museum of Fine Arts, the Massachusetts College of Pharmacy and several other institutions will share to the extent of several millions of dollars in the estate of the late Mrs. Harriet J. Bradbury. The estate is valued at between $12,000,000 and $15,000,000.

More than a quarter of a million dollars has been subscribed to the centennial memorial building fund of the Medical Department of the University of Georgia for the erection of a building to commemorate the one-hundredth anniversary of the founding of the medical school by Dr. Milton Antony in 1823. The sum of $40,000 still remains to be subscribed.

Mr. John D. Rockefeller, Jr., has offered to contribute $250,000 to an endowment fund of $2,000,000 which is being raised for the International Y. M. C. A. College at Springfield, on condition that $1,750,000 be received in cash from other sources before July 1, 1935.

Ohio Wesleyan University has received a bequest of $50,000 by the will of Frank E. Stuyvesant, of Cleveland, Ohio.

The nineteenth Annual Report of the Brooklyn Botanic Garden contains a résumé of research that has been in progress during 1929, including studies of the diseases of cereal grains, beardless iris project, forest pathology, systematic botany and genetics; also a summary of the educational activities. Over 1,127,000 visitors were recorded at entrance turnstiles, and study material including living plants and petri dishes with sterile agar were supplied to 6,457 teachers for the instruction of 282,000 pupils. Over 795,000 packets of seeds were supplied to school children for planting in school and home gardens and 38 exhibits were installed in the public schools of Brooklyn and other boroughs. Numerous gifts are also recorded.

DISCUSSION

COSMICAL MATTER AND STELLAR EVOLUTION

In his address before the British Association for the Advancement of Science at the recent meeting in Cape Town, as given in Science of July 26 last, Lord Rayleigh touches on what would be called in Spanish countries a "palpitating question" in astronomical problems of to-day.

The importance of the underlying cause of the spectral conditions which he discusses can not be overestimated. But there are some points in connection with the nebulae especially in which it seems to me a diversity of opinion is permissible.

Interest in the relation of nebulosity to early-type activity, although not in the same sense as Lord Rayleigh appears to favor, was stated in an article on the cause of stellar spectral differences.[1]

It has been a profound mystery to me why so obvious a source of energy and one so efficacious as cosmical matter has been ignored—not simply unrecognized, for it has been found everywhere, but just ignored. Clouds of it, great and small, abound in the Milky Way; the great nebulae such as Orion, Trifid, Eta Argus and M8 show it; all the spiral nebulae large enough to show detail reveal it; the meteors in our atmosphere, the corona and zodiacal light about our sun are other examples. We also find many variable stars and novae enveloped in clouds which are best explained as such. Comets are doubtless nothing but clouds of such matter, and the asteroids are believed to have a *similar constitution.*

The Pleiades are enveloped in a great cloud of such matter, and a great many early-type stars have clouds either attached or near.

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[1] *Ap. Jour.*, 47: p. 305, 314, 1918.

From the evidence which exists it would be more justifiable to assume that the effects of cosmical matter in some form are universal than that they are negligible.

At this point I would emphasize the criticisms which have been made of the too ready acceptance of anything which is largely mathematical formulas. No one will deprecate the value of mathematics as a tool, but there is entirely too great a tendency to ignore the material upon which the tool is used. Instances are familiar to all; among them may be cited the work on the internal constitution and spectral conditions of the stars and of the distances of the Cepheid variables, globular clusters and spiral nebulae. To these may be added in a lesser degree the parallaxes of the more distant stars determined directly.

Recent happenings point to a drastic revision of distances of the Cepheids, and in consequence, of all the objects based upon them, hence this case need not be pursued. There is still the case of the direct determinations of the parallax which is more obscure and not generally understood. In passing it may be said that the error in question appears to arise from the effect of spectral type on magnitude and consequently distance which has been ignored because unnoticed.

Regarding the first case, my criticism applies particularly to the work which has been done upon the internal conditions of the stars as an explanation of spectral conditions in general.

The spectral condition of a star is essentially a surface condition. It is undoubtedly affected by internal conditions but to what extent is entirely unknown, and in my opinion to place all the responsibility on conditions as hypothetical as internal ones is highly speculative, to say the least. It is even possible to reconstruct Herschel's frozen-cored sun with just as much reason and scientific basis as some of the theories proposed in the past half century. We have in the large meteorites evidence of possible frozen cores and in the existence and effects of cosmical matter a means of producing almost any surface condition as evidenced by the novae.

I am not arguing for frozen-cored suns, merely pointing out the weakness of any theory based wholly on conditions so purely speculative as internal ones.

If there were no other course it might be justifiable.

But there is direct and weighty evidence that much of the spectral condition of the stars, at least the early types, is due to external causes alone. Internal conditions furnish no explanation whatever of the preferences of all these early-type objects including the gaseous nebulae for the Milky Way.

I maintain the thesis that only some sort of external condition or conditions are adequate and logical to cause such preferences and demand the production of evidence to the contrary or that internal conditions alone will account for these preferences.

My object in touching so strongly on the question of the cause of the spectral condition of the early-type objects is to prepare the way to oppose what I understand to be the general attitude toward that problem. Lord Rayleigh focuses the matter when he emphasizes the intimate relation of the central stars of the planetaries to the surrounding gaseous nebulosity. About that fact there can be no reasonable difference of opinion. It is with the underlying assumption that the central star is the exciting cause of the gaseous nebulosity that my criticism lies, but even more with the assumption that the gaseous nebulosity is the starting-point of stellar evolution.

Lord Rayleigh is more physicist than astronomer and therefore is presumably more interested in the purely physical side. He does not definitely so state but I understand his statement that ". . . the source of excitation in the bright line nebulae no longer appears inexplicable" and that "the cases of some of the central nuclei of the planetary nebulae are specially satisfying from the definite relation of the star to the nebula and the adequate character of the star itself" to mean that the central star is considered to be the exciting cause of the nebulosity. Such is almost certainly *not* the case. The evidence favors the hypothesis that *both star and nebulosity have been excited by a common cause.*

In the novae we have what is the only analogous course known and one which appears to satisfy the conditions of formation of these planetary nebulae also. Indeed the only essential difference appears to be in the rapidity in which the novae pass through the different stages. In a few weeks or months the nova passes successively through the spectral conditions A, B, O and gaseous nebulosity. And to complete the analogy some of the brighter novae have presented expanding disks in the nebulous stage.

Not only have we that evidence, but unpublished investigations indicate that the planetary nebulae may be in different stages of expansion and contraction. This is shown both by their radial velocities and their appearances.

If this were not enough we have the further supporting condition that in the O-type stars those showing emission (Wolf-Rayet stars) appear to be expanding whereas those showing only absorption have predominantly positive radial velocities indicating contraction, atmospheric probably.

If such are the conditions in the planetary nebulae and O-type stars strength is lent to the hypothesis that some of the excess of positive velocity in the B-type stars may be due also to contraction. Upon these hypotheses all the early-type activity can be accounted for, even the outstanding and discordant large radial velocities of the planetary nebulae which have been a stumbling-block to the proper location of these bodies in any otherwise logical course of change.

The course followed by these early-type objects, as indicated by the above conditions, may be summarized as follows:

> Stellar (or perhaps other) bodies in the galactic regions where cosmical matter is sufficiently plentiful encounter such matter in the form of clouds of varying conditions as to size and motion.
>
> The effects of such matter begin to be noticeable in the A type, and probably also as short-period variables in the F, G and K types which show a marked preference also for the galactic regions. These preferences become progressively stronger through the B-type stars until we find those of O type confined to a narrow belt along the plane of the galaxy.
>
> These encounters will in general reduce the motions of the original stars due to the combination of different motions of the star and cloud and perhaps also to a general retardation by widely distributed matter which appears to have little or no system motion in many cases. This would account in part for the generally small motions of the early-type objects.
>
> Strong evidence has recently been encountered, however, that the great brightness of the early B-type stars is due to a brightening up of stars whose proper motions were originally small, due probably largely to distance.

The sequences of change in both spectral type and temperature accord with increasing amounts of cosmical matter encountered which first produces an apparent excess of positive radial motion or contraction in the B-type spectrum which increases in the late O-type and then changes to negative or expansion when the emission appears in the early subdivisions.

The planetary and large extended gaseous nebulae are the results of encounters with single stars and groups respectively in which the climax appears to have been produced, resulting in gaseous nebulosity and probably radiations of shorter waves which are not observable with our present means.

Incidentally it may be pointed out that encounters of solid bodies with clouds of cosmical matter furnish an explanation of the large meteorites, these being the pieces of small solid bodies disrupted by the sudden heating of such encounters much as the meteorites themselves are disrupted in passing through the earth's atmosphere.

If such a course is the correct interpretation of the phenomena observed in these early-type objects the nebulosity is not being maintained by "excitation" of a central star or other source but is the *result* of the primitive originating encounter and is simply a stage more or less transitory in stellar evolution, broadly considered.

Indeed the phenomena of the novae and especially the planetary nebulae raise the question whether the secondary bodies of our solar system may not be the later stages of the outer portions of a planetary nebula. The physical appearance of these bodies which show predominating positive velocities is such as to suggest condensation.

As these objects and the novae all show strong preferences for the Milky Way the question naturally presents itself as to what causes the activity in them, activity which appears to increase from A- to B- and O-type and to culminate in gaseous nebulosity in the planetary and large irregular nebulae as well as the novae.

Here is where cosmical matter intrudes itself as outlined above. Together with gravitation it furnishes a natural and satisfactory explanation for this early-type activity, and so far it is the only one. I have hunted diligently for objections but thus far have found none. One object in raising the point is to invite discussion and to uncover contradictory evidence if it exists.

As yet this question is not one for mathematical formulas except incidentally but for broad common sense.

C. D. PERRINE

OBSERVATORIO NACIONAL
CÓRDOBA, ARGENTINA,
SEPTEMBER, 1929

PSITTACOSIS EPIDEMICS AND PLEOMORPHIC PROTOPLASM

THE note in the issue of March 7 on the etiology of parrot disease and the possibility of a filterable virus suggests that laboratory workers in New York State, and perhaps the scientific world generally, may be unfamiliar with the work done during the epidemic of 1917 in Pennsylvania. At that time, Dr. A. T. McClintock, a young Wilkes-Barre pathologist and diagnostician, trained in Vienna and Berlin, carried on extensive researches with cultures obtained from three affected parrots and from the bloods, sputa and feces of eleven patients. He used mice and rabbits for inoculation, checking his results through the experimental induction of similar disease pictures by means of cultures derived from the feces of normal parrots.

His tentative conclusions are suggestive, though in a dozen years laboratory technique has doubtless undergone manifold refinements. While identifying the epidemic as psittacosis, he failed to associate with it Nocard's bacillus (a stout motile Gram negative rod) as the causative factor. Nocard's findings (1892), he believed, represented a fixation of species, whereas the local epidemic (less virulent in form, with a mortality of only 5 per cent.) was apparently derived from a "generalized" bacterial protoplasm, often amorphous, residing in the intestines of the healthy parrot of this species in a harmless saprophytic guise. This more primitive form conceivably retained a plasticity which under the stimulus of abnormal conditions enabled it to undergo metamorphosis, assuming a number of different forms, rodlike or coccal, and displaying an affinity for a wide range of living tissues. The chilling of healthy birds and the resultant changes in intestinal exudates were surmised to serve, in natural surroundings, the same rôle as the bouillon extract which, in the laboratory, sufficed to provoke mutation and the development of pathogenic traits in the intestinal flora obtained from healthy birds.

It was found possible to induce the disease with material which had passed a filter, but in less virulent form, with slower course. In McClintock's opinion, the larger, centrifugible units were more effective. As in previous epidemics, there was an incubation period of from five to ten days, and there was lack of evidence of the transfer of infection from one human being to another. Three forms, influenzal, pneumonic and typhoidal, all accompanied by severe headache, were distinguishable in human patients, though the typical tests for pneumonia and typhoid were negative and agglutination variable. Postmortems, however, revealed the hemorrhagic conditions characterizing the disease picture throughout the tissues, although most frequent in the lungs or intestines of the affected bird or animal. In spite of the mounting evidence of contact between sick birds and patients, the state authorities, so far as I recall, refused to identify the disease as psittacosis.

McClintock's preliminary findings were reported before the Luzerne County Medical Society on May 17, 1917. The detailed account of his researches, including his hypothesis relating the Wilkes-Barre epidemic to a more primitive, less differentiated form than that represented by Nocard's bacillus, lay in manuscript until 1926, owing to conditions peculiar to the war period. McClintock saw a possible connection between the etiology of psittacosis and that of trench fever, and rushed his monograph to conclusion outside the long hours absorbed by his private practice and his duties as pathologist at the city hospital, working over his results from 8 to 12 at night, writing from 5 to 8 A. M. In September, 1918, while hunting a publisher and making final arrangements for army service, he contracted the influenza then epidemic in a severe and all but fatal form, never regaining his health. Publication under the existing war conditions proved impracticable, and so far as I know he never touched his manuscript again. It was printed posthumously in 1926 as "Pleomorphism in Bacterial Protoplasm: A Study in Psittacosis," in a form which the author had hoped would render it useful as an introduction to pathogenic bacteriology —a field in which, his researches convinced him, a less dogmatic approach than the conventional one was desirable.

McClintock's view that psittacosis is not a simple disease entity, that the causative factors in different epidemics may be different and may, in certain instances at least, be derivable from a minute, unfixated protoplasmic form, harmless under normal conditions of the host, certainly merits wider dissemination among laboratory workers.

Elsie Murray

Cornell University

ARTIFICIAL BACILLI

In September, 1928,[1] I communicated to this journal a preliminary report on the discovery of living micro-organisms in certain Precambrian rocks. These investigations have been continued and have involved painstaking and laborious checking of the technique employed. While the indications are still as given in the earlier paper, a final statement with respect to them must await the completion of a little further work. A final report should be ready next summer. Meanwhile, conclusive evidence has been obtained to prove the existence of living micro-organisms in anthracite coal derived from mines in Wales and in Pennsylvania. The interpretation of these results does not accord with those of Schroeder, Galle, Potter and Lieske, who also worked with anthracite coal. I hope soon to furnish a report also on these investigations.

Incidental to the study of the bacterial flora of rocks, however, the attempt to work with strictly sterile media has led to a striking discovery which I present in this communication. When agar in the shredded or powdered form is mixed with tap water, sea water or other salt solutions in the cold, a microscopic examination shows only the irregular shapes and sizes of colloidal particles. When, however, it is heated in such solutions to a temperature of 45° C. or more, a microscopic examination of stained and unstained preparations thereof reveals a large number of perfectly shaped rods varying in length and thickness. These forms are practically always rod-shaped with rounded ends and most strikingly resemble bacilli. They even show diplo-bacillus forms as if the rods were in process of division. They take the methylene blue and gentian violet stains readily and frequently show polar, more deeply stained spherules and other structures in the interior. These rods are not bacteria since even sterilization of the agar for fourteen hours or more in the autoclave at pressures varying from eighteen to twenty-two pounds fails to destroy them, and since besides the original agar suspension does not contain them but a few minutes' heating produces them.

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[1] Science, 68: 272–3, September 21, 1928.

A discussion of this discovery with Professor J. W. McBain, of Stanford University, convinces me that I have discovered a colloidal phenomenon which is the result of the assumption of one form of structure among the compounds of the agar which takes expression in the type of aggregates just described. This form is evidently fairly insoluble and fairly stable. An account of the studies carried out respecting the properties of these artificial bacilli will be published later.

As regards the foregoing statements it may be said that we are dealing with facts which can be easily confirmed by any one. It is fascinating, however, and irresistible to speculate as to whether or not these artificial bacilli may, under the proper environmental conditions, take on the properties of living cells. While of course this seems like a wild notion, I am investigating this possibility.

To Mrs. Dorothy Doyle Thomas, who is assisting me with the laboratory investigations, I wish here to express my thanks.

CHAS. B. LIPMAN
UNIVERSITY OF CALIFORNIA

ACTION OF BACTERIA AND ENZYMES ON CARBOHYDRATES AND THEIR BEARING ON PLANT SYNTHESIS

THE question of the nature of plant synthesis is an important one not only for the plant physiologist but also for the scientist concerned with the structure and industrial application of products of plant metabolism. This is particularly true with regard to the utilization of derivatives such as sugars, starch, inulin, cellulose, etc.

One interesting mode of attack appears to lie in an investigation of the action of bacteria and their corresponding enzymes on carbohydrates and polysaccharides, a method which has been followed with some success by two of my coworkers, Messrs. H. L. A. Tarr and R. S. Tipson. It has long been known that *Bacillus mesentericus* converts cane sugar into "gum levan," and it is now found that the same change is apparently brought about by the enzyme isolated from the bacteria. "Gum levan" has been definitely identified by methylation, acetylation and hydrolysis experiments as a polymerized form of an anhydro fructose derived from "active" or "gamma" fructose. It is closely related to inulin, which is the fructose-anhydride-polysaccharide found in the dahlia and artichoke.

Complete methylation of "levanose" (gum levan), followed by hydrolysis, yields crystalline trimethyl γ fructose, which, so far as known, is the first crystalline active or gamma sugar to be isolated.

The action of *Bacillus mesentericus* and its enzyme is specific. They do not bring about any changes with carbohydrates and sugars in which the active form of fructose is absent. Raffinose apparently yields the same product as cane sugar. The action on gentianose and melezitose is to be investigated.

Bacillus xylinum (Aceto bacter xylinum) acts upon glucose, mannose, galactose, maltose, sucrose, fructose, "levanose," etc., with "pellicle" formation and change of the carbohydrate into a polysaccharide. It appears to convert glucose directly into cellulose. Of the sugars already examined the only one on which it exerts no action is lactose.

The action of both bacteria and enzymes on a variety of carbohydrates is being actively investigated and the preliminary results are to be published in the immediate future in the *Canadian Journal of Research.*

Of considerable interest is the fact that *Bacillus xylinum* is apparently able to carry the polymerization of "gum levan" to a further, more complex, stage.

HAROLD HIBBERT
PULP AND PAPER RESEARCH INSTITUTE,
McGILL UNIVERSITY

SPECIAL CORRESPONDENCE

THE MONTANA TICK PARASITE EXPEDITION TO AFRICA

IT is now possible to summarize the 1928 African tick parasite expedition of the Montana State Board of Entomology. The purpose of the venture was to get as much information as possible on parasites that destroy ticks and particularly to discover new parasites which might be brought to America to be used in the possible control of the Rocky Mountain spotted fever tick, *Dermacentor andersoni* Stiles. The procedure was to collect as many ticks as possible from all kinds of domestic and wild animals, hold them under observation alive and determine if parasites were present. Effort was made to extend the collecting over as wide areas as possible and, at the same time, to give particular attention to those areas where ticks were known to be not very abundant because, where no other cause was evident, parasites might account for the small number of ticks. With laboratory headquarters at the Veterinary Research Laboratory at Onderstepoort, Transvaal, collecting trips were made to various parts of the Union of South Africa and ticks were obtained from all the provinces. Some three weeks' collecting was done also in the Province and Protectorate of Kenya, in the region near Lake Naivasha.

Well over fifteen hundred animals were examined, including many large and small wild animals, and approximately eight hundred tubes of ticks, including some thirty-four species, were collected. An *Ixodiphagus,* closely related to and possibly identical with *I. caucurtei* Du B. of France, was discovered preying on *Hyalomma aegyptium* L. in the Transvaal. This parasite was recovered several times and for the first time it was possible to make a study of an *Ixodiphagus* in a colony of the insects under natural conditions.

The recovery of *Ixodiphagus* and the studies made on the species were considered to be of enough interest to repay for the venture, but the trip resulted in other discoveries which may prove to be of the greatest importance. Six days after the writer sailed from Durban *en route* to Mombasa, Dr. G. A. H. Bedford, entomologist in the veterinary laboratory staff, discovered a chalcid which attacks adult ticks. These insects are not yet named and almost nothing is known about them. Some weeks later, on the occasion of a visit to South Africa, Dr. Robinson, Cooper's parasitologist, when told of the parasite work now being done in South Africa, stated that some years ago he had received a box of adult *Amblyomma hebraeum* Koch from Cape Province and on arrival in England the box was found to contain adult chalcids which had emerged in transit. He further stated that the insects were evidently of a species different from the one discovered by Dr. Bedford, which Dr. Robinson had an opportunity to examine. This chalcid likewise has not been named or studied. It is therefore reasonably certain that there exist in South Africa two new chalcid parasites of adult ticks which the writer did not have opportunity to study.

Through Mr. C. B. Philip, of the West African Yellow Fever Commission, Rockefeller Foundation, Lagos, Nigeria, Africa, we have learned also of the recent discovery of a colony of an unidentified tick parasite in Nigeria.

The parasite expedition to Africa has indicated that the continent is a promising field for further search. A thorough study of the parasites in Africa will be a necessary preliminary to their importation into America.

R. A. COOLEY

BOZEMAN, MONTANA

QUOTATIONS

DR. WELCH'S "APOTHEOSIS"

WHAT the Grecians called "apotheosis," said Bacon, was "the supreme honor which man could attribute unto man." In that definition of the word, the supreme attribution of honor to Dr. William H. Welch to-day becomes his apotheosis. The nation pauses to give him its highest praise while he still lives. Another great physician, Sir Thomas Browne, in his "Religio Medici," said that he cared for not so much as the bare memory of his name to be found anywhere after his death save in "the universal register of God." But fame pays little attention to the prayers of those whom she delights to honor. It is he among teachers who has overcome that "last infirmity"—the desire to be remembered—that is most likely to be chosen. Dr. Welch has gone his way doing what his kindly genius has suggested without other prompting than the appeal of the thing that needed to be discovered or done for humanity.

He has been called "a first citizen of the scientific world." He has three major achievements to give substance to the distinction that will outlive the personality which has made him both loved and admired. He organized the faculty of the Johns Hopkins Medical School nearly fifty years ago and the Johns Hopkins School of Hygiene and Public Health fifteen years ago. Then, with an undaunted spirit which discredits the general theory of his associate, Dr. Osler, he began when he was almost twice forty years old to develop the history of medicine as a new discipline in the training of physicians, with a library as his laboratory. The fourscore years have not abated his "eternizing passion" in the warfare against the enemies of man's bodily health and social welfare.

The substance of his achievement has been illumined by an old-time spirit of scholarship and graced by an art which is the "happy science of the soul." Like the one who is mentioned by Theocritus in his tribute to Asclepius, the father of medicine, Dr. Welch "put all his art into the work." That is his special distinction. He is both scientist and artist in the highest meanings of both words.

Hippocrates found life short and the art of healing long. Fortunately the life of this great modern physician who took early the Hippocratean oath has been lengthened to make more serviceable to his fellow-beings the art of healing, in both its preventive and its curative ministries. There is nothing left to wish him but still more years in the practice of this art before he "goes to the stars."—*The New York Times.*

SCIENTIFIC APPARATUS AND LABORATORY METHODS

HEAT TRANSMISSION THROUGH BLANKETS

Some three years ago I was approached by a large manufacturer of blankets with the request to devise a method for measuring the "heat-retaining property" of blankets. These tests were to be not only for the sake of determining the coefficient of heat conduction of various kinds of blankets, but especially for the purpose of obtaining some data on the basis of which blankets could be improved.

There were, of course, the usual well-known methods available, but it seemed desirable to test larger samples than were generally used and also under conditions which more nearly resembled actual usage. Since what we may call the "normal conditions" for a blanket in use are based on body temperature and room temperature, I devised an apparatus in which the heated body was kept at 37° C. (98.6° F.) and surrounded by air at the temperature of a cool room, 13° C. (55.4° F.). The apparatus finally took the form shown in Fig. 1.

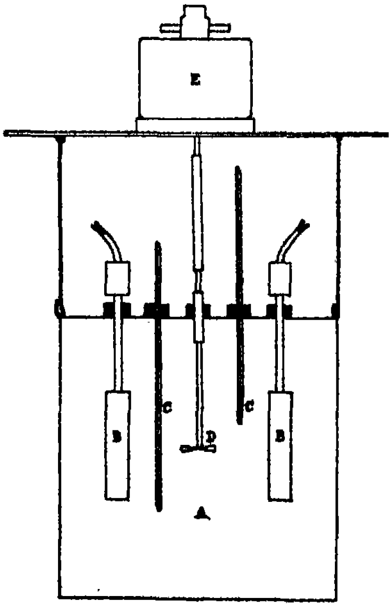

Fig. 1

A is a copper vessel 12 x 12 x 3½ inches, rounded at the sides and bottom and closed with a flat plate at the top. In the plate are five apertures from which are suspended by rubber or cork stoppers two immersion heaters B, two thermometers C and an agitator D, run by a motor E. The thermometers are placed so that one has its bulb a few inches below the center of the body and the other as much above. The vessel is filled with water, and when the stirring device is in motion the difference between the two thermometer readings is about 0.1° C. The body is suspended from the upper shelf of the food compartment of an electric refrigerator and the stirring motor is placed on this shelf and connected to the propeller shaft by rubber tubing. The temperature of the air in the food chamber is controlled by a Tagliabue Snapon controller, the bulb of which is not in the brine but in the food chamber, behind the body and near the back wall of the refrigerator. This control gives a maximum variation of about 1½° C. from mean.

The energy is supplied to the heaters by a storage battery and measured by a precision voltmeter and ammeter. The temperature of the body is measured by the two thermometers C, and the temperature of the box by two thermometers not shown in the figure, one placed in front of the body near the door and the other near the right-hand wall of the refrigerator. A cardboard screen placed directly inside the door of the refrigerator and low enough to enable the reading of the thermometers prevents the cold air from rushing out when the door is opened for observations.

The procedure in making tests is as follows. The blanket to be tested is cut in the form of a rectangle 17 x 32 inches and pinned into the shape of a bag which fits over the body snugly but without strain. It is drawn on from below and pinned together at the top, allowing B, C and D to project through. The current through the heaters is now adjusted until the average temperature of the body is 37° C. This of course takes a considerable length of time. The temperature of the box is constantly changing with the turning on and off of the compressor, and inasmuch as an increase above 13° decreases the flow of heat through the blanket and a decrease below 13° increases the flow of heat, there is an accompanying variation in the temperature of the body even though the power supplied remains constant. The rate of variation is of course the same as that of the refrigerator but there is a slight lag. The amplitude of variation of the body temperature depends upon the insulating quality of the blanket used and becomes unnoticeable in case of the "warmest" ones. The rate of change of the refrigerator temperature depends upon the quality of the blanket used and the room temperature and is greatest for a poor blanket and a high room temperature, as the rate of flow of heat into the refrigerator is then the greatest and the compressor has to work most often.

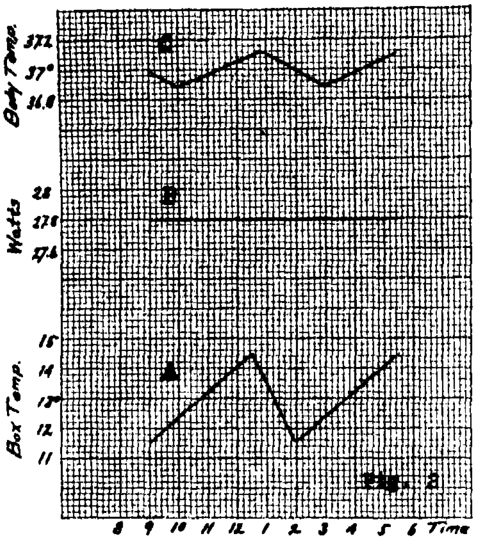

Fig. 2

Fig. 2 shows plots of readings obtained in the test of a good cotton blanket. Curve A shows the variation of the box temperature with time; curve B the power supplied to the body, and curve C the resulting temperatures of the body. The power in watts supplied to the body when its average temperature is 37° while the average temperature of the box is 13° is a measure of the heat-insulating property of the blanket under test. It may be mentioned here that the power supplied to the stirring device is insignificantly small.

Inasmuch as the number of watts which have to be supplied to the body is least for the best blanket it seemed desirable to obtain a measure which was numerically greater for the better insulator. This was done by determining the watts needed when the body was covered with only a cotton sheet in place of a blanket and using as the measure the difference between this value and that for a given blanket. This difference, of course, is greatest for the best blanket.

Knowing the area of the covering and the power supplied, it is possible to compute the energy in B. T. U. which passes through ten square feet of any blanket in eight hours. This I have adopted as my unit in blanket testing. An interesting result obtained was that a single thickness of heavily napped cotton blanket gave 2,730 of these units, which corresponds to the heat value of about two thirds of a pound of lean beef.

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SPECIAL ARTICLES

THE EFFECT OF COLLOIDAL SILICA ON THE ABSORPTION OF PHOSPHORIC ACID BY PLANTS

Replying to a criticism of Fisher[1] concerning the interpretation of the effect of sodium silicate in increasing the assimilation of phosphoric acid by barley in the Rothamsted field experiments, Hall[2] suggests that an explanation of the phenomenon may be sought in the colloidal behavior of the sodium silicate in accordance with the theory advanced by Comber.[3] The latter maintains that the soil colloids play an important rôle by being directly absorbed by plants through the formation of a one phase system between the colloidal coating of the plant root hairs and the colloidal coating of the soil particles. This proposed modification[3] of present views by Comber,[3] however, has been critically discussed by the writer,[4] who has shown that the weight of existing evidence does not support the theory of the absorption of colloids by plants.

There is ample evidence,[5,6,7,8] moreover, to disprove the view that silica may act as a substitute for phosphoric acid in the metabolic processes—it is not "phosphorsäuresparend"; nor can the view[9] that the observed effect is due to the improvement in the physical condition of the soil withstand critical investigation.[10] Relative to the alternative explanations presented by Hall and Morison,[7] certain authorities[1,6,8] have concluded from the increased quantity of phosphoric acid per dry weight of the crop that the beneficial effect of silica is due to the increased availability resulting from an increase in the quantity of phosphoric acid in the soil solution. Gile and Smith[6] and also Lemmermann[8] concluded that this action is a solvent one on the soil phosphates. The former[6] substantiate their conclusions from experiments (albeit *in vitro*) which showed a greater solubility of rock phosphate in the presence of silica gel, whereas the latter[8] recognizes that the explanation just advanced is incomplete. The fact, however, that plants can thrive in extremely dilute solutions of phosphate ion if the supply is maintained[11, 12] even as low as 0.25 p.p.m.[13] proves that the solvent effect of silica on soil phosphates, as suggested by these investigators, is a negligible factor compared with the other more powerful solvent forces present.

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[1] R. A. Fisher, *Jour. Agr. Sci.*, 19: 132–139, 1929.

[2] A. D. Hall, *Jour. Agr. Sci.*, 19: 586–588, 1929.

[3] Norman M. Comber, *Jour. Agr. Sci.*, 12: 363–369, 1922.

[4] Walter Thomas, *Soil Sci.*, 27: 249–270, 1929.

[5] Wl. S. Butkewitsch and W. W. Butkewitsch, *Biochem. Ztschr.*, 161: 468–487, 1925.

[6] P. L. Gile and J. G. Smith, *Jour. Agr. Res.*, 31: 247–260, 1925.

[7] A. D. Hall and C. G. T. Morison, *Proc. Roy. Soc.*, B-77: 455–477, 1906.

[8] O. Lemmermann, H. Wiessmann and K. Sammet, *Ztschr. Pflanzenernähr. u. Düngung*, 4A: 265–315, 1925.

[9] Fr. Duchon, *Ztschr. Pflanzenernähr. u. Düngung*, 4A: 316–325, 1925.

[10] O. Lemmermann, *Ztschr. Pflanzenernähr. u. Düngung*, 4A: 326–330, 1925.

The seat of action ultimately must be in the plant itself,[7] for the absorption of ions by the plant is conditioned by the equilibrium conditions prevailing in the interface of the system composed of the ions in the plasma membrane of the root hairs and the ions of the soil solution. Now, in a system containing a non-diffusible ion—$SiO_3^{=}$ in the case under discussion—a marked effect is exerted on the distribution of diffusible ions on either side of the cell membrane. A non-diffusible electro-negative ion, such as a colloid micelle,[4] will produce a greater concentration of diffusible electro-negative ions and a lower concentration of electro-positive ions on its own side of the membrane than on the other. A non-diffusible electro-positive ion will produce the opposite effect. According to the Gibbs-Donnan distribution law[14, 15] at equilibrium the product of the concentrations of each pair of oppositely charged diffusible ions is the same on both sides of the membrane. Hence, in the system under consideration if x and y represent the molar concentrations of the diffusible H and PO_4 ions, respectively, on each side of the interface considered, and z the concentration of the non-diffusible SiO_3 ions, then, according to the Donnan principle, displacement of the diffusible ions takes place in such a way that at equilibrium $x = y(y + z)$. It follows that the greater the concentration of non-diffusible anions ($SiO_3^{=}$) present, the greater must be the absorption of diffusible anions ($PO_4^{\equiv}$) into the cell. The equation also shows that x and y are equal only when $z = 0$. Practically, there is a limit to the amount of silica that might be added, because of the coating of the root hairs and other factors.[5] Obviously, the Donnan effect will be restricted by the presence of diffusible $xSiO_2 \cdot yH_2O$ ions, some of which will be present in the solution.[4]

The experiments of Butkewitsch and Butkewitsch[5] with collodion membranes and also with maize plants grown in Pfeiffer's nutrient solution with and without phosphoric acid to which different amounts of silicic acid were added afford the first experimental evidence in support of the interpretation just submitted.

It is realized that the Gibbs-Donnan distribution law may not suffice to explain all the facts connected with the absorption of ions from the soil solution by the plasma membrane of the root hairs of plants, for the Donnan principle applies to free ions only. From Wright's investigations[16] on the secretion of the high amounts of calcium in milk from the relatively low concentrations of this element in the blood plasma, it is apparent that the degree of dissociation of the protein salts must be taken into consideration also, since these ions are present in the cell in addition to those which entered to satisfy the product equation. The plant cell is a polyphase system; from this starting-point Briggs and Petrie[17] have deduced that the apparent internal ionic product resulting from the collective effect of all the phases within the tissue in this polyphase system must have a higher value than that of the external medium. It must be kept in mind, however, that deductions from experiments[17, 18, 19] in isolated tissues or cells of plants, although supplying valuable information, may not necessarily conform to the behavior of the plant as a whole. Herein, from the plant physiology standpoint, lies the value of the type of experiments carried out by Butkewitsch and Butkewitsch.[5]

It remains only to be pointed out that in the Rothamsted experiments sodium silicate, a salt showing a strong tendency to hydrolyze, was used, whereas in the other experiments cited in this paper the silica was added in the form of silicic acid gel. The effect, therefore, of hydrogen-ion concentration on the mobility of ionic pairs must also be considered.[20, 21]

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[11] D. R. Hoagland and J. C. Martin, *Soil Sci.*, 16: 367–388, 1923.

[12] F. W. Parker, *Soil Sci.*, 24: 129–146, 1927.

[13] J. F. Breazeale and P. S. Burgess, *Arizona Agr. Exp. Sta. Tech Bul.*, 10: 209–237, 1926.

[14] F. G. Donnan, *Ztschr. für Elektrochem.*, 17: 572–581, 1911.

[15] F. G. Donnan and A. B. Harris, *Jour. Chem. Soc.* (*Lond.*), 99: 1554–1557, 1911.

[16] Norman Charles Wright, *Biochem. Jour.*, 23: 352–357, 1929.

[17] G. E. Briggs and A. H. K. Petrie, *Biochem. Jour.*, 22: 1071–1082, 1928.

[18] W. J. V. Osterhout, *Jour. Gen. Physiol.*, 8: 131–146, 1925.

[19] W. J. V. Osterhout and M. J. Dorcas, *Jour. Gen. Physiol.*, 9: 255–267, 1925.

[20] Pierre Girard, *Compt. Rend.*, 148: 1047–1050, 1909.

[21] Pierre Girard and Victor Morax, *Compt. Rend.*, 170: 821–823, 1920.

SEGREGATION (?) IN PHOMA TERRESTRIS

While engaged in a study of the pink-root disease of *Allium cepa* the writer isolated the causal organism *Phoma terrestris*[1] from infected onion roots obtained from the following states: Arkansas, California, Colorado, Louisiana, Massachusetts, New York, Oregon and Texas. Though all the isolated fungi apparently are of the genus *Phoma* and all are able to cause the pink-root disease, they differ markedly in their morphological cultural characters, such as in abundance, shape and size of pycnidia, number and length of ostioles, color of mycelium and substratum, rate of growth, etc. The differences, both macro and microscopic are so obvious and of such magnitude that, were it not for the fact that all these organisms are able to cause the same specific disease, one would be justified (according to precedents set in the taxonomic treatment of other genera in fungi imperfecti) in naming three new species and several new varieties.

In considering causes for such striking variations one might suppose that either an undiscovered perithecial stage exists or that mutations (saltations) are of unusually frequent occurrence. During the past five years extensive culturing on a large variety of media has failed to show any sector formation, and during that period of time no perfect spore-form has been observed either in nature or in culture. Hence other explanations must be sought.

A more intimate study of the California organism revealed the fact that if constant spore-mass transfers were made through several generations pycnidia were produced earlier and in much greater abundance than by mycelial transfers. This phenomenon, which has also been observed in other genera of the imperfect fungi, indicates that the genetic constitutions of spores and hyphae are dissimilar and that therefore single-spore cultures might be expected to differ in some degree from the parent culture. This was found to be the case. Though several morphological characters showed variations during this investigation, only color of the culture as a whole will be considered here. Of fifty single-spore cultures from the California organism forty-two were pink like the parent and the remaining eight were dark, almost black. Several generations from single spores proved this dark variant to be homogenic for color. Subsequent generations of the pink form gave both pink and black in various proportions varying from 10 per cent. black to 36 per cent. black, with an occasional individual producing only pink progeny, showing that in so far as color character of culture is concerned we have homogenic individuals of both the dominants and the recessives. Combining the pure dark with the pure pink by mixing either spores or mycelium gives rise to a uniform culture that is pink. Single-spore cultures from such a union give rise to cultures of four color types, pink, dark, yellow and purple, but apparently with no definite genetic ratios.

Inoculation experiments on onion seedlings with variants obtained from single spores also show considerable variation in pathogenicity, indicating that use of the single-spore method in obtaining pure cultures may prove confusing to both mycologist and phytopathologist.

The fact that *Phoma terrestris* breaks up into variants when singe-spore cultures are made indicates that segregation of character factors occurs, and the fact that it remains constant when it is perpetuated by mycelial transfers indicates that segregation takes place during pycnidium formation or spore maturation.

Tentative experiments with *Fusarium martii* var. *phaseolus* indicate that members of the genus *Fusarium* may behave similarly. The problem is being studied further by cytological methods.

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[1] "Etiology of the Pink-root Disease of Onions," *Phytopathology*, 19: 691–704, 1929.

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Barry, Mary Elizabeth, and Paul R. Hanna. *Wonder Flights of Long Ago*. Pp. x + 204. 23 illustrations. 5 maps. Appleton. $2.00.

Cleland, Herdman F. *Why be an Evolutionist?* Pp. xi + 73. Coward-McCann.

Cowdry, Edmund V., Editor. *Human Biology and Racial Welfare*. 28 Contributors. Pp. xviii + 612. Illustrated. Hoeber. $6.00.

Dehn, Edgar. *Algebraic Equations*. Pp. xi + 208. Columbia University Press. $4.25.

Elwyn, Adolph. *Yourself, Inc.* The Story of the Human Body. Pp. 320. 71 illustrations. Brentano's. $3.50.

Kaempffert, Waldemar. *Reading with a Purpose;* Invention and Society. Pp. 38. American Library Association. $.35.

"Quest" Expedition Report on the Geological Collections made during the Shackleton-Rowett Expedition to the South Atlantic & Weddell Sea in 1921–1922. Pp. 161. 26 figures. 3 plates. British Museum. 12s. 6d.

The National Physical Laboratory. Report for the Year 1928. Pp. vi + 283. 59 figs. London; Published by His Majesty's Stationery Office for the Department of Scientific and Industrial Research. 9s.

Stanley, Douglas. *The Science of Voice*. Pp. vi + 327. Illustrated. Carl Fischer, New York.

Snyder, Harry. *Bread*. Pp. x + 293. 20 illustrations. 15 maps. Macmillan. $2.50.

Triangulation in Hawaii. Pp. vi + 240. U. S. Government Printing Office. $.50.

Twenty-first Report of the Henry Phipps Institute for the Study, Treatment and Prevention of Tuberculosis. Illustrated. Henry Phipps Institute.

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INTERNATIONAL COOPERATION IN GEOGRAPHICAL WORK[1]

By Dr. WILLIAM BOWIE

U. S. COAST AND GEODETIC SURVEY

IN my capacity as a delegate from the United States I am representing the National Geographic Society of Washington, D. C., as well as the Department of Commerce of the United States government.

The officials of the National Geographic Society requested me to extend to this assembly their most cordial greetings and their best wishes for a bright and distinguished career for this institute which we are now bringing into existence.

The officials of the National Geographic Society are deeply interested in all phases of geographical science. They have done much to bring the nations of the world into closer touch with each other by the dissemination of accurate geographical information supplemented by a remarkable series of pictures in their splendid *National Geographic Magazine* that is known to every educated man in the world. The officials have expressed to me the hope that they may have very close contact with the officials of the Pan-American Institute of Geography and History in order that the science of geography may be carried even further than it has been in the past.

They expressed the hope that the government agencies of the various American nations which are engaged in any phase of geographical science will receive the support of those officials of the government who have to do with the allotment of funds for these official geographical services. They also expressed the hope that non-official agencies, such as geographical societies or geographical departments of universities, may be stimulated by the organization of the Pan-American Institute of Geography and History to carry on their operations on a wider and grander scale than may have been the case in the past.

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[1] Address delivered before the Pan-American Institute of Geography and History, meeting in Mexico City, September 17, 1929.

The officials of the National Geographic Society are not unmindful of the fact that this institute is to cover history as well as geography. In fact, they realize that there is a close association between historical research and the geographical environment of those regions for which the historical studies are undertaken. It is, in fact, impossible to divorce geography from history. The historian can not properly discover or interpret the motives that impelled large or small groups of people to act in a certain way unless he knows the geographical conditions which prevailed at the time such action was taken. Surely the character of the climate and of the terrain, as well as the presence or absence of rivers and streams or ocean fronts, has tremendous bearing on the development of the civilization of a tribe or a nation.

However, my ability to discuss history in its broad and technical phases is limited, and I will leave to our delegates who are historians the task of properly setting forth the place that historical research will have in our new institute.

The officials of the National Geographic Society wish me to convey to you their earnest desire that the efforts of the people in the western hemisphere, acting under the leadership of our institute, should be successful in discovering the historical facts and in setting them forth in books or papers in order that the data secured may be used for the purpose of making the life of the dweller in the western hemisphere fuller and richer. With knowledge comes power, and with power we have the means of raising the scale of living and increasing the happiness of the citizens of each of the American nations.

We have heard much in recent decades of the application of scientific principles to agriculture and other great industries, in exchange of goods and in communication. But science can only go a certain distance towards bettering the condition of humanity and making civilization grander and nobler without having geographical facts. It is here that the geographer must supplement the work of the physicist, the chemist and the engineer, for without the geographical information and background the other sciences can not well be efficiently employed in the utilization of the resources which nature has given abundantly to the nations of the world.

The officials of the National Geographic Society have expressed frequently, and do on this occasion through me, their opinion that civilization will be greatly advanced by an early completion of the mapping of the world. We are all familiar with the sheet of paper on which are drawn the margins of the continents which are equally the limits of tidal waters. How frequently these maps are totally inadequate to convey accurate information as to the geographical locations of points within the country, their elevations, the accurate location of mountain ranges, rivers, streams and highways, nor do they show the slope of the ground. Without all these essential geographical data the map user can not form accurate and detailed pictures of the conditions within the area covered by the map.

On the other hand, there are in existence for certain portions of the area of each country topographical maps which do carry these essential data. The officials of the society would like to see the day when there is an adequate topographical map covering the area of each of the countries in the western hemisphere. Much mapping has been done in my country, but only 44 per cent. of its area has as yet been topographically surveyed, and many of the map sheets are inadequate, owing to age or deficient methods employed in the survey, to meet the needs of agriculture, mining, the development of hydroelectric power and extension of transportation systems and systems for the transmission of power and communication.

The engineers and other leaders in industry are making their wants known in regard to topographic mapping, and it is practically certain that within the next few years each country of the world which is not already supplied with topographic maps will increase its activity in the mapping line. It has truly been said that only a rich nation can afford to develop its natural resources and its industries without previously having executed the topographic surveying and mapping.

I have expressed to you the opinions and wishes of the officials of the National Geographic Society, and I hope I have made it clear that they wish to help the Pan-American Institute of Geography and History in every way that is possible for them and that they stand ready to cooperate with the institute and the geographical services of the American countries in developing the western hemisphere in the interests and the welfare of humanity.

The western hemisphere is new to civilized man. It is less than 450 years since Columbus discovered the new world and opened up a vast area which was destined to have such a great influence on the development of civilization. We, in this generation, have a great responsibility thrust upon us. We must hand down to posterity our countries with their natural resources. If we are wise we will develop and utilize these resources for our present needs, but we will do so in such a way that we shall not impoverish those generations which are to follow us. In this development and utilization the geographer should and must play a leading and important rôle. It is here that the Pan-American Institute of Geography and History can exert a great influence for good by outlining geographical problems that should be attacked and solved and in disseminating geographical principles and data which may have been discovered. A fact is of no value if locked in the mind of a single geographer. It is useful only when he has published the results of his investigation and research in order that every one may have the benefits of his work.

I am sure you will be interested in knowing more intimately the National Geographic Society and the scope of its activities. It is organized on the democratic principle that each of its 1,200,000 members has a share in supporting the magazine that it publishes and the exploration work to which it has given financial support. Also the membership supports financially the various lines of educational work which are carried on by the society.

Each member is, on the other hand, entitled to know just what have been the results of the explorations that have been conducted under the society's auspices. He must be kept informed of changed geographical positions which may occur in widely separated parts of the world. He is entitled to have the maps which are compiled and printed by the society and he is also entitled to the results of the world-wide photographic survey of matters of geographical interest which the staff of photographers of the society is making.

All these data are furnished to every member through the society's *National Geographic Magazine* and in special technical publications which are issued from time to time and give the results of geographical explorations.

The society is independent of governmental control. It is a private institution and receives no funds from the government of our country. However, it cooperates with governmental agencies which are carrying on geographical research or investigations, and it from time to time will finance a project which may be advocated by a government official who has not at hand governmental funds for carrying on work. There are two notable examples of this. First, the exploration of the Carlsbad Caverns in New Mexico by the late Dr. Willis T. Lee, who was a member of the U. S. Geological Survey. Another was a reconnaissance survey of the active and extinct volcanoes along the Alaskan Peninsula and the Aleutian Islands by Dr. Thomas A. Jaggar, also a member of the U. S. Geological Survey.

The society has done a noteworthy service to science in disclosing the history and art treasures of pre-Columbian civilization both in North and South America.

Seven expeditions of the society to Chaco Canyon, under the leadership of Neil M. Judd, unearthed and explored the remains of America's finest prehistoric communal dwellings. One of these pre-Columbian "apartments," Pueblo Bonito, housed some 1,500 people, had 350 rooms on the ground floor and yielded an amazing array of utensils, art objects, ceremonial appurtenances and other evidences of their daily life.

You are familiar with the Pedregal area, south of Mexico City, with its mass of unweathered lava from the volcano Xitli. Beneath that "Stony Place" is a blanket of soil, and underlying the soil is another lava flow of the remote past. There an expedition of the society led by Dr. Byron Cumming found encased remains of a people who flourished at a period variously estimated at from 3,000 to 6,000 years ago. Clay images, bone awls, ear ornaments and other objects of this earliest known American civilization, which flourished in your country, are seen by thousands of the National Geographic Society's members when they visit its headquarters in Washington, D. C.

Dr. Ernest G. Holt is now leading one of the society's expeditions which is exploring the haunts of birds in the southern parts of Venezuela. Bird life is the principal objective, but observations of the terrain, the animals and other life forms and the amazing variety of tropical plants are being made.

The National Geographic Society has a research committee whose chairman is now Dr. F. V. Coville, botanist of the Department of Agriculture of the federal government. This committee investigates carefully every project for which financial assistance is asked. There have been many cases where the committee has recommended and the trustees have made grants of funds for worthy projects. The most recent one was the appropriation of $50,000 from its research fund and the assignment of certain scientific personnel for the expedition of Commander Byrd to the Antarctic Continent.

Somewhat earlier it supported financially Admiral Peary's expeditions to the Arctic regions. It contributed financial aid and scientific guidance to the Wellman Polar Expedition, which went to Franz Josef Land in 1898 and made biological and geological collections and in addition observed atmospheric temperatures and other conditions. The data collected were of high scientific value and also an aid to later explorers in that region.

A technical representative was detailed by the society to accompany the Ziegler polar expedition of 1903–05 to direct the scientific work. In 1925 it sent out an expedition to northern Greenland and Ellsmere Island during which Commander Richard E. Byrd gained his first flying experience in polar regions.

One of the most notable pieces of geographical work done by the National Geographic Society was in the Mount Katmai region in Alaska. As is well known, that mountain erupted in 1912, and the ashes from the eruption covered a wide area. The primary purpose of the studies undertaken by the society was observation of the rejuvenescence of the flora which had been obliterated. The exploration party to Mount Katmai observed that the eruption had left a crater almost as large as the one in Vesuvius. When they crossed the mountains towards Bering Sea they discovered a vast area from which were rising innumerable columns of steam. This area, which was investigated intensively by four subsequent expeditions under the direction of Dr. Robert F. Griggs, was called the Valley of Ten Thousand Smokes. The funds necessary to finance these expeditions all came from the treasury of the National Geographic Society. Accounts of these explorations at Katmai have been published in the magazine of the National Geographic Society and also in a series of technical papers.

It would take too much time to tell you of each of the explorations or pieces of geographical research that have been carried on by the society or financed from its treasury, but what I have told you is, I am sure, sufficient to convince you of its high standing, and of the vast scope of its activities. It will, I am sure, encourage you to know that this great organization, through its officials, has expressed such deep interest in the future of the Pan-American Institute of Geography and History. The society is an ally that the institute will be glad to welcome in its efforts to advance geographical science and knowledge in the western hemisphere.

The officials of the National Geographic Society are thoroughly convinced that geographical information, if properly prepared and disseminated, should be as interesting to the child as it is to the adult. With this idea in view the society undertook and is successfully carrying on a great work in connection with the public schools of my country. About 35,000 school teachers obtain daily illustrated lessons in geography from the society conveying information too recent to be found in text-books. These lessons and pictures are used by the teachers in disseminating geographical knowledge to the children. Geography is to-day one of the popular subjects taught in the elementary schools, while a decade or more ago it was considered to be very dull and stupid.

Not only is the society issuing bulletins to school teachers throughout my country but at the request of the editors of about six hundred newspapers they are furnished daily bulletins on geographical subjects. I can not imagine any greater help in the stimulation of the interest of people in geography than this news service of the National Geographic Society.

While not one of the really old geographical societies of the world, the National Geographic Society may yet claim maturity or at least vigorous youth. It was founded in 1888 and has continued its existence from that time. It sends its greetings to the youngest geographical organization, the Pan-American Institute of Geography and History, which begins its existence on September 16, 1929.

The society has been a pioneer in the line of making geographical information valuable and interesting. There are few persons in the world who will read a dull statement no matter how accurate or valuable the data contained therein may be. There is so much literature in the world to-day that we instinctively are drawn towards that portion of it which is prepared in an attractive way, an article or a book that will hold our attention until we have completed it. Dr. Gilbert Grosvenor, president of the National Geographic Society, has reached almost the point of genius in the geographical field by making the magazine of the society carry the message of geography to even the humblest homes. His magazine is read by the highest officials of the national government and in the humblest fisherman's dwelling along the sea-coast, by the miner in his mountain camp and the farmer in his cottage. This is truly a great accomplishment and is a tribute to him.

The officials of the National Geographic Society are not strangers to the citizens of the other American nations. There have appeared many articles, beautifully illustrated, in its magazine depicting certain phases of the geography and history of the countries lying to the south of the United States. We may expect that the society will continue to publish these most interesting articles from the other countries of the western hemisphere which I can assure you are read with the greatest interest by the people of my country.

The society's work is substantially aided by its 3,700 members in Mexico and by 10,260 other members in Central and South American countries. This total of 13,960 members of this great geographical body from the Latin-American countries is a gratifying token of the interest and support you are tendering the advancement of geography.

I have brought with me a series of maps which have been published by the National Geographic Society which I have been asked to give to the director of the Pan-American Institute of Geography and History with the compliments of Dr. Grosvenor.

Upon my return to Washington I shall report to the officials of the National Geographic Society with a great deal of pleasure the proceedings which have led to the formal organization of the Pan-American Institute of Geography and History and I shall assure them that in my judgment the institute is built on a broad foundation and that its future should be a bright one. Also that its work will undoubtedly result in a vast stimulation of geographical and historical research in the western hemisphere and that the results of such activities should redound to the benefit of the citizens of each of the countries which is adhering to the institute.

OBITUARY

ARTHUR McQUISTON MILLER MEMORIAL SERVICES

ARTHUR MCQUISTON MILLER, for thirty-five years professor of geology and archeology in the University of Kentucky, author of "The Geology of Kentucky" and other works, fellow of the Geological Society of America since 1897, died in Florida on October 28, 1929, of heart failure. The members of the society are invited to join in a meeting to be held in his memory on Memorial Day, Friday, May 30, at Lexington, on the lawn of his home, Maxwelton, adjoining the grove which he gave to the university. The chief speaker on the occasion will be Professor Collier Cobb, of the University of North Carolina.

Dr. Marion M. Miller, brother of Professor Miller, extends the hospitality of Maxwelton to all members of the society who can arrange to be present on the occasion. There are ample accommodations in this fine old mansion for a large group of scientific men and their families.

A committee of the leading citizens of Lexington, representative of the civic bodies of which Professor Miller was an active member, will have charge of the memorial and dedicatory exercises. Judge Samuel M. Wilson, Security Trust Building, is chairman, and to him tributes may be sent by members of the society who wish to pay their respects in this manner to Professor Miller's memory. Those who plan to attend should notify Dr. Marion M. Miller, Maxwelton, Lexington, Kentucky.

It is hoped by Dr. Miller that his guests will come prepared to spend the week-end in the Bluegrass country. A trip will be taken on Saturday to the Kentucky River Gorge, the great Dix River Dam, and to old Shakertown near the dam, where a banquet will be held in the Shakertown Inn. A memorial volume containing the addresses and tributes will be published during the summer and will be sent to members of the society.

MEMORIALS

THE Connecticut Agricultural Experiment Station has issued *Bulletin* 312 as a memorial to Dr. Thomas B. Osborne, who died in January, 1929. Dr. Osborne joined the station staff in 1886 at the invitation of Professor Samuel W. Johnson, director, and professor of agricultural chemistry in Yale University. Two years later he began his studies of the vegetable proteins that were to continue uninterrupted for forty years in the same laboratory. More than two hundred and fifty papers bear his name. The bulletin, entitled "Thomas B. Osborne: A Memorial," opens with an appreciation by Dr. E. H. Jenkins, director emeritus of the station. Dr. Osborne's work is described at length in an article, reprinted from SCIENCE, by Dr. H. B. Vickery, who succeeded Dr. Osborne as head of the station biochemistry laboratory, and Professor Lafayette B. Mendel, of Yale, who for many years collaborated with Dr. Osborne in nutrition experiments. This is followed by six of Dr. Osborne's papers, biographical notices and a complete bibliography of his work.

OFFICIAL notice has been received from the United States Geographic Board that the south arm of Port Snettisham, in southeastern Alaska, near latitude 57° 59′, longitude 133° 44′, has been named Gilbert Bay; and that the lake about 5 miles long lying to the eastward of that bay and about 10 miles inland from Stephens Passage has been named Gilbert Lake, in honor of the late Dr. Charles H. Gilbert, the ichthyologist, who was connected with the Bureau of Fisheries for many years. *The Fisheries Service Bulletin* writes: "It is fitting that tribute is thus paid to the memory of one who attained world-wide distinction in the field of ichthyology; and whose untiring investigations concerning the salmon fisheries, especially those of Alaska, contributed largely to the knowledge of these important fishes, both from a scientific point of view and from the standpoint of practical conservation."

RECENT DEATHS

DR. JOSEPH L. MARKLEY, professor emeritus of mathematics at the University of Michigan, died on April 20 in his seventy-first year.

DR. JOSEPH M. PATTON died on April 17 at the age of seventy-eight years. Dr. Patton had been a professor of clinical medicine at the College of Medicine of the University of Illinois and professor of internal medicine at the Chicago Polyclinic.

PROFESSOR C. KELLER, of the University of Zurich, known for his work on the fauna of Somaliland and the Red Sea, has died at the age of eighty-two years.

It is reported that I. M. Michaelovsky, professor of physiology in the Mid-Asiatic University at Tashkent, has died from suicide or murder.

Nature reports the death of Sir William M'Cormick, chairman of the University Grants Committee and of the Advisory Council on Scientific and Industrial Research, on March 22, aged seventy years; and of Sir Edward Brabrook, a past president of the Royal Anthropological Institute, on March 20, aged ninety years.

SCIENTIFIC EVENTS

A CHEMISTRY HOUSE IN LONDON

According to the London *Times* the project to assemble all the chief chemical, metallurgical and mining societies in one new building at Westminster was outlined on March 27 by Professor J. F. Thorpe in his presidential address to the British Chemical Society at its annual meeting in Burlington House. He also put forward suggestions for securing ultimately a joint membership of the Chemical Society and the Society of Chemical Industry.

It is proposed that the central building for scientific and technical institutions shall be erected and equipped at a cost of £350,000, in Victoria Street, with the object of securing the close association between the scientific societies of the industries which has already been achieved in America and is in process of realization in France. The building will have a large common lecture hall and a library of about 70,000 volumes. It is intended also to provide club facilities.

In his address, as reported in the *Times*, Professor Thorpe spoke of the development in science and industry resulting from the application of lessons learned during the war. He said the spirit of cooperation or rationalization was causing many groups dealing with related subjects to join together in their own and in the national interests. It was certain that the next 20 years would witness a struggle for supremacy in scientific effort and in the industrial application of science throughout the world which would be even more intense than was the struggle between the contending nations during the war. It must be recognized that the separation into isolated units of the organization dealing with the scientific and technical development of the three basic industries was not in accordance with the existing state of scientific knowledge, and that the nation and empire could not utilize to the full the forces inherent in them unless some scheme could be devised by which close cooperation between these groups could be effected.

The need was urgent, because other nations, notably the French, were actively engaged in coordinating their chemical activities, and the Americans already had their Chemists' Club in New York. Unless, therefore, something was done, and that quickly, they would be handicapped in the struggle. It seemed that at last they were in a fair way to realize the Chemistry House of their needs at a cost which was about half what would be necessary if chemists were forced to act alone. They must look to the industries concerned to provide the greater proportion of what was required. When the general appeal was issued it would contain a list of definite promises amounting to £130,000, including some munificent personal donations, such as £10,000 from Mr. Robert Mond, £1,000 from Mr. Emile Mond and £1,000 from Sir Robert Hadfield. A petition had been sent to the chancellor of the exchequer asking for a Treasury contribution. The answer, however, was *"non possumus,"* although sympathy was expressed with the object in view.

Professor Thorpe then discussed proposals for the first steps towards a union of the Chemical Society and the Society of Chemical Industry. He said it would probably require twelve months' work on the part of the joint committee to elaborate all the necessary details and explore every avenue leading in the desired direction.

A SCIENTIFIC ADVISORY BOARD FOR THE WESTINGHOUSE RESEARCH LABORATORIES

The first meeting of the recently created Scientific Advisory Board of the Westinghouse Research Laboratories was held in East Pittsburgh, Pennsylvania, on April 16. The aim of the Westinghouse Electric and Manufacturing Company in establishing this board is to bring before their specialists recent scientific research.

The members of the board are: Dr. P. W. Bridgman, head of the department of physics at Harvard University; Dr. G. B. Waterhouse, head of the department of metallurgy at the Massachusetts Institute of Technology and chairman of the ferrous advisory committee of the U. S. Bureau of Standards; Dr. C. E. Mendenhall, head of the department of physics at the University of Wisconsin; Dr. Stephen Timoshenko, head of the school of advanced mechanics at the University of Michigan, who formerly worked for four years at the Westinghouse Laboratories, and Dr. Edward Mack, Jr., professor of physical chemistry in the Ohio State University.

It is planned that the board shall meet three times a year and that the individual members will follow closely all research work conducted by the company and act in an advisory capacity on matters concerned with pure science.

In a statement made by Mr. S. M. Kintner, manager of the laboratories, he says: "It is our purpose that the board members advise us along purely scientific lines. We expect them to stimulate our research specialists by their suggestions, to bring up-to-the-minute theories into our work and to act as a check on the scientific work upon which we are engaged."

Some members of the board will serve for one year and the others have been appointed for two-year terms. Thus, as changes are made in the personnel, there always will be members who have served for at least one year.

Plans now are being carried through for the enlargement of the present laboratories. An addition to the present building which will nearly triple the floor space is under construction at a cost of $500,000. The addition, which includes a large power house, will centralize the laboratories, some of which through lack of space have been forced to find quarters in the main plant.

THE TWENTY-FIFTH ANNIVERSARY OF THE ILLINOIS STATE GEOLOGICAL SURVEY

THE Illinois State Geological Survey through Dr. M. M. Leighton, chief, announces the celebration of its quarter-centennial anniversary. The celebration will be held in Urbana, on April 30 and May 1, in conjunction with the annual meeting of the Illinois Academy of Science on May 2 and 3, and will include two symposia, one on "Research Needs of Illinois' Coal Industry," and the other on "Studies Relating to the Order and Conditions of Accumulation of the Coal Measures." Many state and academic geologists have signified their intentions of being present, since the topics of discussion have wide-spread applications.

The proceedings will open with the dedication by Dr. Edson S. Bastin of the Quarter-Centennial Program to the memory of T. C. Chamberlin and R. D. Salisbury.

The dedication will be followed by a historical retrospect of geological investigations in Illinois and their relations to the state, when the speakers and subjects will be:

Investigations previous to the founding of the present State Geological Survey: PROFESSOR C. W. ROLFE.

The initiation of the State Geological Survey: DR. H. FOSTER BAIN.

The State Geological Survey during the period 1909–1923: MR. FRANK W. DEWOLF.

The State Geological Survey during the period 1923–1930: DR. M. M. LEIGHTON.

Speakers taking part in the symposium on the research needs of Illinois' coal industry will be Dr. M. S. Ketchum, Dr. J. A. Garcia, Dr. E. A. Holbrook, Dr. F. C. Honnold, Dr. S. W. Parr and Dr. Reinhardt Thiessen. Studies relating to the order and conditions of accumulation of the coal measures will be reported by Dr. J. Marvin Weller, Dr. H. R. Wanless, Dr. R. C. Moore, Dr. F. B. Plummer, Mr. Wilber Stout, Mr. David B. Reger, Dr. G. H. Ashley and Dr. David White.

Those who will take part in the discussions that will follow the symposia include Professors A. C. Willard, W. H. Severns and Dr. T. E. Savage, of the University of Illinois; Dr. Gilbert H. Cady, Illinois State Geological Survey; Dr. G. F. Kay, state geologist of Iowa and dean of the college of liberal arts and sciences, University of Iowa; Dr. H. A. Buehler, state geologist of Missouri; Dr. G. E. Condra, dean and director of the conservation and survey division, University of Nebraska; Dr. C. N. Gould, director of the Oklahoma Geological Survey, and others.

THE AMERICAN PHILOSOPHICAL SOCIETY

THE annual meeting of the American Philosophical Society opened in Philadelphia on April 24. The Saturday night session commemorates the two hundred and third anniversary of the founding of the society by Benjamin Franklin, in April, 1727.

There will be a dinner on April 26 at the Bellevue-Stratford with Captain Sir Hubert Wilkins, explorer; Dr. James Rowland Angell, president of Yale University, and Dr. Edwin Grant Conklin, professor of zoology, Princeton, as speakers, and Dr. John H. Finley, of the New York *Times*, as toastmaster. Sir Hubert's subject will be "Seeking Useful Knowledge"; Dr. Angell's, "Promoting Useful Knowledge," and Dr. Conklin's, "The Service of Science to Mankind."

Papers and a report of progress will be presented in the "intellectual stock-taking" inaugurated last year by Dr. Francis X. Dercum, the president. All day-time sessions at which these papers will be read will be in the 141-year old hall of the society.

Papers on Thursday's program were read by Dr. Clinton J. Davisson, Dr. Herbert E. Ives, both of the Bell Telephone Laboratories; Professor Arthur E. Kennelly, Harvard University; Professor Clyde Eagleton, New York University; Professor Emory R. Johnson, University of Pennsylvania; Dr. Alfred V. Kidder, Carnegie Institution of Washington; Professor William B. Scott and Dr. Glenn L. Jepsen, Princeton University, and Professor Henry Fairfield Osborn, American Museum of Natural History.

The program for April 25 includes the annual address of the president, matters of business and the election of officers and members, and papers by Dr. Detlev W. Bronk, Professor Rodney H. True, Dr. Harlan H. York, Professor Ephraim Avigdor Speiser and Professor John C. Rolfe, University of Pennsylvania; Dr. Albert F. Blakeslee and Dr. Howard J. Banker, Carnegie Station for Experimental Evolution; Dr. George W. Crile, Cleveland Clinic and Cleveland Clinic Hospital; Dr. Frederick S. Hammett, Research Institute of Lankenau Hospital, and Dr. Daniel T. MacDougal, Carnegie Institution of Washington.

The afternoon session on Friday is given over to a symposium on the outlook for higher education in the United States which was organized by Dr. Frank Aydelotte, president of Swarthmore College. The speakers are Dr. Abraham Flexner, former secretary of the General Education Board; Dr. F. J. E. Woodbridge, former dean of the Graduate School, Columbia University, and Dr. Aydelotte.

On Friday evening there will be a reception in the hall of the Historical Society of Pennsylvania and an illustrated lecture by Professor William F. Albright, of the Johns Hopkins University, entitled "A Millennium of Biblical History in the Light of Recent Excavations."

Speakers on Saturday morning will be Professor Fay Cooper-Cole, University of Chicago; Dr. Aleš Hrdlička, U. S. National Museum; Professor Roland B. Dixon, Harvard University; Dr. George Grant MacCurdy, Yale University; Professor David Reisman and Professor L. V. Heilbrunn, University of Pennsylvania; Professor E. Newton Harvey and Dr. Peter A. Snell, Princeton University; Professor J. H. Ashworth, University of Edinburgh, and Professor Samuel A. Mitchell, University of Virginia.

Saturday afternoon will be devoted to a symposium on astronomy and astrophysics organized by Dr. John A. Miller, director of Sproul Observatory, Swarthmore. In addition to Dr. Miller the speakers will be Professor Ernest W. Brown, Yale University; Dr. John S. Plaskett, director of the Dominion Astrophysical Observatory, Victoria, B. C.; Professor John Q. Stewart, Princeton University, and Professor Harlow Shapley, director of Harvard College Observatory.

SCIENTIFIC NOTES AND NEWS

IN connection with the ceremonies in honor of the eightieth birthday of Dr. William H. Welch on April 8, an address with lantern illustrations was given at the London School of Hygiene and Tropical Medicine by the director, Sir Andrew Balfour, on Dr. Welch's life and work.

DR. CHARLES VALUE CHAPIN, who, beginning in 1884, was for a long series of years superintendent of health of Providence, Rhode Island, was presented with the Sedgwick Memorial Gold Medal for outstanding achievement in public health at the banquet of the New England Health Institute. The presentation was made by Surgeon-General Hugh S. Cumming, of the U. S. Public Health Service.

THE doctorate of science was conferred on Dr. C. G. Abbot, secretary of the Smithsonian Institution, by the Case School of Applied Science on the occasion of the installation of Dr. William Elgin Wickenden as president of the school. Dr. Abbot gave an address on "The Opportunities of Science."

DR. RODNEY H. TRUE, of the University of Pennsylvania, who is visiting Tucson, Arizona, and other points in the Southwest in connection with the work of the Committee of One Hundred of the American Association for the Advancement of Science, gave the John Wesley Powell Lecture at the University of Arizona on April 22.

PROFESSOR M. I. PUPIN, of Columbia University, has been elected president of the University Club of New York City.

DR. OSKAR LOEW, professor of chemical physiology in the University of Berlin, has been awarded the Liebig Medal of the Bavarian Academy of Sciences, in recognition of his services to agriculture.

AT the meeting of the Chemical Society, London, on March 27, the Longstaff Medal was presented to Dr. W. H. Mills, lecturer in organic chemistry at the University of Cambridge, and the Harrison Memorial Plaque and Prize to Dr. R. P. Linstead.

DR. HANS MOLISCH, professor of botany in the University of Vienna, celebrated the fiftieth anniversary of his doctorate on March 20.

DR. ALEXANDER WETMORE has been elected a foreign member of the British Ornithologists' Union. Dr. Wetmore sailed from New York on April 10 for Spain, where he will be engaged for a month in making collections of birds for the National Museum in the Cantabrian Mountains. Later he expects to visit museums in Paris, Brussels and London, and then to attend the International Ornithological Congress in Amsterdam.

THE sixtieth annual meeting of the Wisconsin Academy of Sciences, Arts and Letters was held at the University of Wisconsin on April 11 and 12, in joint session with the Wisconsin Archeological Society and the Midwest Museums Conference. Officers of the academy were elected for a term of three years as follows: *President,* Charles E. Allen, University of Wisconsin; *Vice-presidents, Sciences,* Rufus M. Bagg, Lawrence College; *Arts,* O. L. Kowalke, University of Wisconsin; *Letters,* William E. Alderman, Beloit College; *Secretary-treasurer,* Lowell E. Noland, University of Wisconsin; *Curator,* Charles E. Brown, State Historical Society; *Librarian,* Walter M. Smith, University of Wisconsin.

DR. FREDERICK W. SCHLUTZ, recently head of the pediatrics division at the Medical School of the University of Minnesota, has been appointed to a similar post in the University of Chicago's South Side Clinics. Dr. Schlutz has arrived in Chicago to direct organization work for the Bobs Roberts Memorial Hospital for Children.

DR. CHAS. H. BEHRE, JR., assistant professor of geology at the University of Cincinnati, has resigned to accept an associate professorship of economic geology at Northwestern University.

DR. HOWARD H. MARTIN, assistant professor of geography at the University of Cincinnati, has been appointed associate professor of geography in the College of Science, University of Washington, Seattle, the appointment to take effect on October 1.

DR. JULIAN D. CORRINGTON, assistant professor of zoology at Syracuse University, has been appointed associate professor of biology at Drew University, Madison, N. J.

AT a meeting of the Michigan State Board of Agriculture, April 4, the following appointments and promotions were made at Michigan State College: Dr. Marie Dye, acting dean of home economics, dean of home economics; Dr. E. A. Bessey, acting Dean of applied science, dean of the graduate school; Dr. R. C. Huston, professor of chemistry, acting dean of applied science; Dr. D. T. Ewing, associate professor of chemistry, professor of physical chemistry, and Dr. W. A. Kelley, instructor in zoology, assistant professor of zoology. Dr. Bessey retains the headship of the department of botany and Dr. Huston remains in charge of the work in organic chemistry.

DR. PHILIPP BROEMSER, of Bâle, has been called to a professorship of physiology in the University of Heidelberg.

MR. WARD SHEPARD, assistant chief of public relations in the Forest Service, resigned on March 31 to become associated with Dr. Gifford Pinchot in forest work.

DR. HERBERT C. WARD, chief of the bureau of bacteriology of the Maryland State Department of Health, has resigned to accept a position with a commercial house in Chicago.

DR. P. L. GAINEY, of the department of bacteriology of the Kansas State Agricultural College, will represent the college at the second International Congress of Soil Science to be held at Moscow and Leningrad in July.

THE Committee on Scientific Research of the American Medical Association has made an appropriation of $500 to the department of bacteriology of the School of Medicine and Dentistry of the University of Rochester at Rochester, New York, for research on chemotherapy in tuberculosis. The grant is to aid the work of Dr. Georges Knaysi, of the New York State College of Agriculture, who has been granted leave of absence by Cornell University and will conduct his experiments at the University of Rochester.

PROFESSOR A. S. HITCHCOCK gave an illustrated address before the Botanical Society of Washington on April 1 on "A Botanical Trip to South and East Africa."

DR. J. ARTHUR THOMSON, Regius professor of natural history at the University of Aberdeen, delivered a lecture on April 5 before the Royal Canadian Institute on "The Drama of Animal Life."

DR. JONATHAN CAMPBELL MEAKINS, of McGill University, will lecture on "Hypertension" at the Medical School, University of Buffalo, under the Harrington Foundation, on May 1 and 2.

ON April 22, Captain Sir Hubert Wilkins addressed the American Geographical Society on "Further Antarctic Explorations." He described the results of his 1929–1930 expedition, including his aerial flights over a part of the Antarctic Archipelago, Charcot Island and the ice pack farther west, and outlined his plans for the setting up of meteorological stations in the Antarctic. Through the use of moving pictures he showed the contrast between the old and the new methods in polar exploration.

FOR his Friday evening discourse delivered at the Royal Institution on March 28, Sir Ernest Rutherford took as his subject "The Transmutation of Matter."

A SYMPOSIUM in Theoretical Physics will be given during the summer school at the University of Michigan, from June 30 to August 22. The program is as follows: Professor P. Ehrenfest, University of Leyden, "Problems of Modern and Classical Physics"; Professor E. Fermi, University of Rome, "Quantum Electrodynamics"; Dr. Philip M. Morse, Princeton University, "Quantum Mechanics"; Professor S. A.

Goudsmit, University of Michigan, "Theory of Atomic Spectra," and Professor G. E. Uhlenbeck, University of Michigan, "Application of the Theory of Probability in Physics." Professor Ehrenfest will conduct seminars twice a week which will give opportunity for informal presentations and discussions of the most recent problems of modern physics.

Professor H. L. Bolley, dean of biology in the North Dakota Agricultural College, botanist and plant pathologist at the Experiment Station, has been granted leave of absence for the year beginning on July 1. He will spend some months in temperate regions of South America, particularly in Argentina, making observations and photographic records on botanical and agronomic lines similar to the studies he has conducted in North Dakota. He will make a study of the ecological relations of parasites and hosts in relation to sanitary cropping, giving special attention to smuts, rusts, root and seedling blights.

During the spring holidays, a party from the Brown University department of geology made a week's trip through parts of Connecticut, New Jersey, Pennsylvania, New York and Massachusetts. Observations were directed by Professor Bradford Willard, and were confined chiefly to the character, structure and fossil content of the Paleozoic formations. Professor B. L. Miller, of Lehigh University, conducted the party through part of the Lehigh Valley cement belt. Of particular interest were the new Alexander Caverns near Reedsville, Pennsylvania. A considerable number of fossils was secured for the department collections.

Syracuse University will send an expedition to the Andes Mountains next January for four months of exploration. Using the modern city of San Cristobal as the base of operations, the expedition will explore the unknown country for 200 miles about the city. Included in the party will be Dr. Struthers, who is director of the Syracuse University Museum of Natural Science; Dr. Ernest Reed, botanist; Sidman Poole, professor of geography at Syracuse University; Dr. Earl T. Apfel, professor of geology and oil-geologist; Dr. Edward Reid, of Rome, New York, doctor and surgeon, and Ellis Thompson, assistant purchasing agent, business manager. Professor Struthers has lived two years in tropical America in preparation for the expedition and has led four expeditions into various parts of the Caribbean. Special equipment is being taken for exploring some of the rivers flowing into the Orinoco. It is planned to divide the party into at least two groups at San Cristobal in order to cover more ground and let men work in regions especially favorable to their particular objectives. At least once a month the groups will return to San Cristobal for reorganization and coordination of data. Contact with headquarters will be kept at all times by the use of native runners.

The State Department announced on April 16 that an expedition for the exploration of the northeast coast of Greenland will be carried out this summer at the request of the Museum of the American Indian, Heye Foundation. The expedition will be in charge of Captain Robert A. Bartlett, who will be accompanied by Junius Bird, on the schooner *Morrissey* of eighty tons. They will collect archeological and ethnological specimens. The *Morrissey* will go to Scoresby Sound and northward, remaining in Greenland from 6 to 8 weeks.

Applications for associate and assistant metallurgist, at salaries of $3,200 and $2,600 a year, respectively, must be on file with the Civil Service Commission at Washington, D. C., not later than May 28. The examinations are to fill vacancies in the departmental service, Washington, D. C., and in the federal classified service throughout the United States. The duties are to conduct mining and metallurgical investigations and dissemination of information with a view to improving conditions in the mining, quarrying, metallurgical, and other mineral industries, especially with a view to preventing unnecessary waste of resources and otherwise contributing to the advancement of these industries. The optional subjects are (1) ferrous metallurgy, (2) nonferrous metallurgy, (3) physical metallurgy, and (4) ore dressing. Applications must be on file with the commission not later than May 14, for the positions of associate entomologist ($3,200 to $3,700 a year) and assistant entomologist ($2,600 to $3,100 a year), to fill vacancies in the Bureau of Entomology, Department of Agriculture, and in positions requiring similar qualifications. The optional subjects are (1) apiculture, (2) biological control of insects, (3) cereal and forage insects, (4) deciduous fruit insects, (5) forest insects, (6) insects affecting man and domestic animals, (7) tropical and subtropical insects, (8) truck crop insects.

The London *Times* reports that after several months' labor the skull of the Peking Man has been freed from its stony matrix and was on view at the annual meeting of the Geological Society of China on March 29. Much delicate work with dentist drills and special tools was required to cut away the mass of hard travertine in which the skull was embedded. The process revealed the absence of the facial part of the skull, but the heavily developed supraorbital ridges remain, and the cranium is complete except at the base. Dr. Black stated that the study of the cleaned skull had not yet begun, and there was nothing fresh to say on the subject except that the skull showed a peculiar condition of the ear region in shape and a very unusual expansion of the tympanic bone, from which, after examination, important conclusions might be reached. In the course of the meeting it was stated that geologists had made the interesting discovery that the volcanoes in the Tatungfu coal area in North Shansi had ejected quantities of lava, which covered the sands and clays formed approximately during the same period as the Choukoutien deposits in which the remains of the *Sinanthropus Pekinensis* were found.

Anopheles gambiae African was found breeding in Natal, Rio Grande do Norte, Brazil, on March 23, by Mr. Raymond C. Shannon, who is engaged in entomological research in connection with the yellow fever studies of the Rockefeller Foundation in Northern Brazil. The cable reporting this discovery says that this is the first Myzomyia found in the New World. Mr. Shannon is of the opinion that the species is probably of recent importation to Brazil, although the large numbers of larvae and pupae found indicate it to be well established in the vicinity of Natal. Dr. L. O. Howard, entomologist for the U. S. Department of Agriculture, comments as follows: "The cablegram about Shannon's finding is extremely interesting. *Anopheles gambiae* is found in many places in Africa. It is wide-spread throughout the coastal belt of South Africa, is a recognized carrier of malaria throughout the Ethiopian region and is known in Zululand, Zanzibar, all through Portuguese East Africa, southern Rhodesia, in Nairobi, the Gold Coast and Mauritius. It is a common frequenter of houses and a ready carrier of malaria. It is, in fact, the species that appears on the crest of the Royal Society of Tropical Medicine. The name *Myzomyia* occurring in the cablegram is that of a genus of Anopheline mosquitoes founded by Blanchard in 1902. It is now considered to be subgeneric in rank. The species heretofore have been known only from Africa and India. Natal, Brazil, is a seaport and therefore a likely place to look for introductions of this kind. Since Mr. Shannon has found it breeding there, it is likely to have become a permanent resident; and thus we know of another bad malaria carrier in the Americas."

ON April 2, 1930, the seminars of the departments of psychology and zoology of the University of California met together to hear and discuss a paper by Professor Emeritus Wm. E. Ritter entitled "Is Man a Rational Animal?" By way of a general introduction Professor Ritter said: "According to the system of thought descended to us from Plato through Descartes, Kant and others, psychology is the science of the mind and biology is the science of the body. This makes life a house divided against itself. What psychology has suffered from the conception of bodiless minds is not for me to say. What biology has suffered from the conception of mindless bodies I could discourse on long and, I think, convincingly. It would be a fine thing, it seems to me, if this joint meeting of psychologists and zoologists might be the first of many similar meetings to the end of replacing the divided house theory of life by a united house theory. This might lead finally, for our own university at least, to a philosophy of life symbolized by the fact that so many of the sciences devoted to living nature are now housed together in this magnificent new building with its conspicuous label, 'The Life Sciences.'"

Industrial and Engineering Chemistry reports that the United States Court of Appeals for the Third District has held that the ownership of patents seized from enemy owners by the Alien Property Custodian during the war and the right to recover the royalties paid to the Treasury of the United States by lessees for their use rests with the purchaser, the Chemical Foundation, which acquired the patents from the Alien Property Custodian under executive order. The patents were owned before the war by three German organizations and, under the Trading with the Enemy Act, were seized by the Alien Property Custodian, and licenses to use them were granted to E. I. du Pont de Nemours & Co., Inc. The royalties which the du Pont Company was required to pay were subsequently turned over by the Alien Property Custodian to the Treasury of the United States before the patents were sold to the Chemical Foundation. The latter filed a bill in equity to recover from the Treasury of the United States so much of the license money as would cover the royalties. Almost immediately the German owners filed similar suits and the Alien Property Custodian filed a motion to be substituted for the German owners. The Circuit Court held that upon seizure of the property the enemy owners lost their rights thereto, as well as their rights to royalties, and therefore at the time of their filing the bill they were not owners of either. The ownership of the Alien Property Custodian was also denied by the court on the ground that in his sale to the Chemical Foundation he had disposed of every right acquired under the seizure. The court finally ruled that both ownership and right to royalties were vested in the Chemical Foundation. This decision upholds that of Judge Hugh M. Morris, of the Federal District Court of Delaware.

The program of papers to be read by international authorities at the World Poultry Congress in July is now being prepared. Papers in the British section will come under five heads—(*a*) breeding and incubation; (*b*) nutrition and rearing; (*c*) diseases and their control; (*d*) economics and marketing; (*e*) education and general—while in addition there will be several papers on rabbits. Professor R. C. Punnett will contribute an important paper dealing with experiments on the inheritance of fecundity in fowls, and Mr. Tom Barron, the pioneer breeder of pedigree laying stock, will explain the Lancashire Utility Poultry Society's breeding scheme, which for the first time introduces the principle of the stud book in poultry breeding. Dr. G. Scott Robertson, of the Ministry of Agriculture of Northern Ireland, will speak on nutrition of the chick and the effect on growth; Mr. Tom Newman will contribute a paper on food in relation to the hen; Professor Parkhurst, of the National Institute of Poultry Husbandry, will discuss the use of cod-liver oil in the ration of the laying hen, and Dr. J. B. Orr, principal of the Rowett Institute, will tell of the mineral and protein requirements of poultry. Dr. Ethel Cruikshank and Dr. F. C. Kelly will speak of the uses of iodine in the poultry yard, and papers on diseases stand in the names of Major Dalling, Captain Doyle and Mr. E. Lionel Taylor. Mr. A. W. Street, Professor A. W. Ashby and Captain Hunt are among the readers of papers on economics and marketing, and on the educational side the contributors will include Dr. Charles Crowther, of the Harper Adams Agricultural College, and Mr. P. A. Francis, director of the congress. Since the resumption of diplomatic relations the Soviet government has accepted an invitation to be represented at the congress, and arrangements are being made whereby a national exhibit will be staged showing phases of poultry practice in Russia.

The proposal last July by the director of the British Museum for a new edition of the General Catalogue of Printed Books has resulted, according to the London *Times*, in a large number of advance applications for the work. Two hundred subscribers are already guaranteed from the United States, together with 130 from British librarians and librarians abroad, many of whom have received prospectuses through the Foreign Office. A second and more definite prospectus is accordingly being issued immediately by Sir Frederic Kenyon, the director of the museum, in which the full terms of subscription are announced. The volumes, consisting each of 500 pages, are to be issued to original subscribers at £3 each, while the published price will be £4 a volume. The trustees of the museum propose alternately to accept a sum of £400 in advance for the complete catalogue as issued. It will consist of about 165 volumes, but not more than 12 of these will be issued in any year. They will be delivered in batches at intervals of six months, while a monthly record of accessions is to be issued for a subscription of £3 a year. It is to be observed that the form sent out to would-be subscribers imposes certain safeguards upon the conditions of sale, and some discretion is allowed the trustees to refuse to accept the names of certain subscribers, to increase the price of volumes still to be issued should the cost of production increase, and to vary the terms of their performance owing to war, strikes, fire and other forms of *force majeure*. Should the price of any volumes be in fact increased subscribers will have the right to discontinue. Two announcements of changes in the plan of the catalogue also appear. The practice of regarding I and J as the same letter (and similarly of U and V) will be abandoned, and the heading "Academies," under which learned societies have hitherto been classified, will vanish in favor of a distribution of those societies beneath local headings, according to the town which is their headquarters. Work on the catalogue has already been set in progress under the retiring keeper of books, Mr. R. Farquharson Sharp. His successor, Mr. Marsden, has been compelled to refuse a number of applications for work on the catalogue from outside the museum. It should be made known that no unofficial help is at present required. The work is expected to take from 15 to 20 years.

DISCUSSION

THE FUTURE OF TAXONOMY

In discussing the inadequacy of support given the *Zoological Record*[1] Professor T. D. A. Cockerell ascribes the situation to (1) the competition of *Biological Abstracts* and (2) the lack of interest in taxonomy. With regard to the first I will only call attention to the fact that the publishers of the *Zoological Record* were complaining of inadequate support long before *Biological Abstracts* came into being,[2] and that they even threatened to discontinue the publication of this valuable bibliographic work if more adequate financial support was not forthcoming.[5]

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[1] Science, 71: 240–241, February 28, 1920.

[2] Science, 54: 663, 1921.

It is probably true, in the entomological field at least, that there is a relatively small percentage of the total number of workers engaged in taxonomic research, but I do not believe this to be due to a lack of interest. On the contrary, the evidence that is available seems to indicate that there has been a steadily increasing interest in taxonomy during the last seventy years, not only in the United States but throughout the world. The number of papers published in any particular field is, I believe, some indication of the interest taken in that field. In a recent paper, as yet unpublished, the writer has pointed out that there has been a steady increase in the number of papers published in the field of entomological taxonomy from 1864 up to the present time. This is true both for the United States and for the world as a whole. The only noticeable slump in the output of such papers was during the world war years.

Professor Cockerell goes further, however, and attributes this alleged lack of interest in taxonomy to our graduate schools. The reasons that are given to justify this indictment of the graduate school system are (1) lack of equipment, that is, library facilities and museum material, and (2) the inherent inadaptability of taxonomy as a thesis subject for graduate training. In these days when every reputable institution has at its command the convenience of interlibrary loans, lack of library facilities is not the reason that students are not preparing themselves as taxonomists. With respect to museum material, I believe it is true that those institutions which have most developed graduate training in entomology have the largest and best insect collections outside of the established museums. The material in those collections and the insect material in many of the museums are available to first-class graduate students for purposes of research, so that lack of material is not the reason taxonomy is not more generally chosen as a thesis subject. The charge that the subject of taxonomy is not suitable for a thesis problem because of the inherent difficulties involved is one that can be made regarding any field of science. Not all the problems in taxonomy are adapted to the needs of graduate school training; neither are all the problems in experimental zoology, genetics, ecology or any other branch of science so adapted, but no one contends that any of these fields as a subject is unsuitable for graduate training. Taxonomy is no different from these other fields in this respect, and it will be found that there are many problems of a taxonomic nature that can be easily adapted for the needs of graduate school training.

While there may be no lack of interest in taxonomy there seems to me to be no question that entomological taxonomy in competition with other fields of entomology is not attracting the number of capable young men that are needed in this field. The cause of this situation is very obvious. Entomological taxonomy is not receiving financial support in the same proportion as other lines of entomological work. Not only is the number of positions available in this field ridiculously low, but the salaries allotted to those positions are much lower than those for similar ones in other fields of entomology. Taxonomy, then, is competing with these other fields in attracting capable men, with a handicap of few positions and low salaries. Naturally there is a "lack of interest" in taxonomy. The result of this competition is that at present there are hundreds of full-time workers in the research field of economic entomology compared with a mere handful in entomological taxonomy. This proportion is reflected in the staff of the Bureau of Entomology which on July 1, 1929, had 257 workers of the rank of junior entomologist and above, engaged in economic work, and sixteen workers of similar rank in taxonomy. The latter are flooded with specimens of insects sent in from all parts of the country for identification so that the amount of time that can be spent in actual research is exceedingly small. The young man of to-day, then, who considers preparing himself as a taxonomist in entomology faces the prospect of few available positions, a distinctly lower salary than that paid to other entomologists and, if fortunate enough to obtain a position, very little time for actual research. Professor Cockerell asks why it is "that the Bureau of Entomology with its really enormous appropriation and abundance of technicians of all sorts has never given us a monograph on the Coccidae." The answer is that there is only one man in the Bureau of Entomology with the training and experience necessary for producing such a monograph, and he is so loaded down with routine identification work and administrative duties that he has practically no time for research. The same statement is applicable to practically all other taxonomic workers in entomology throughout the country. If taxonomy is to progress and perform its function adequately with relation to other entomological activities it must receive greatly increased financial recognition. Salaries should be increased and the number of workers considerably augmented to take care of the increasing demands made by workers in related fields. When these conditions come about, and they must come about if entomologists in general are to be adequately served by the taxonomists, there will be no "lack of interest" in taxonomy. Capable men will be attracted to the field and graduate schools will perform their function of providing them with the scientific training necessary for research in taxonomy.

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[5] SCIENCE, 57: 577, 720, 1923.

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MARCH 6, 1930

PRESSURE POTENTIAL IN A FLUID

THE above title is intended to designate a concept in connection with a fluid pressure field similar to the concept of electric and gravitational potential. It is presented with the expectation of adverse criticism. However, to the author's mind, there are several points in favor of the concept.

First. According to the defining equation, $p = F/A$, pressure is a vector quantity, which is inconsistent with the equation, $pV = \text{work}$, in which p is apparently a scalar quantity. Now if we define absolute pressure potential at a point in the fluid as the work per unit volume required to produce a displacement, the inconsistency is removed, provided p, in the second equation, designates this pressure potential. The difference in potential between two points is defined as it is for the electric field. Such a potential might be thought of as a condition of stress existing in the fluid, whereby a pressure (vector quantity) is caused to act on a surface in contact with the fluid if there is a difference in pressure potential between the two sides of this surface. The symbol P is suggested.

Second. The water analogue used in teaching current electricity is made more complete and can be used in teaching static electricity if this scalar quantity, pressure potential, is used instead of the vector quantity, p. The analogue can even be carried through the equations.

Third. The treatment of sound is materially aided by such a concept. The pressure potential gradient in a sound field gives a pressure field intensity and an acceleration similar to the gravitational field intensity and acceleration in connection with the gravitational potential gradient. The analogue might also be carried over to electromagnetic waves.

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CONGLOMERITE, A NEW ROCK TERM

GEOLOGISTS make careful distinction among sand, sandstone and quartzite, basing the separation upon the relative degree of cementation of the grains of each type of deposit. Thus, sand is simply a mass of uncemented grains, usually predominantly of the mineral quartz. Sandstone goes a step farther in that the grains are cemented together in varying degrees of firmness. In quartzite the cementing is still firmer, amounting usually to a welding together of grains with matrix. The distinction is usually not difficult to make. Sandstones themselves vary in degree of cementation from such friable examples as crumble between the fingers to those which break only with difficulty under the blows of the hammer. However, in every true sandstone the cement yields more easily than the grains so that fracture takes place in the matrix *around* rather than *through* the individual particles of sand. When a quartzite is broken, however, it is noted that the fracture passes, usually with equal ease, through both grains and matrix. So much for the nomenclature of relatively fine-grained types; what of the coarser sediments?

When we attempt to distinguish pebbles as gravel from conglomerate, the separation is simple, exactly like that by which sand and sandstone are differentiated. That is, the individual pebbles in a gravel bank are not cemented one to another, but the fragments of rock, "phenoclasts," in a conglomerate are cemented together. However, there appears to be no term in general use for distinguishing among conglomerates those in which fracture is through the matrix, from those types in which fracture is through matrix and pebble with equal ease. These conditions are of course analogous to those encountered in sandstone and quartzite respectively. Examples of indurated conglomerates in which there has been a welding together of matrix and pebbles are not rare. They are particularly well illustrated in the partially metamorphosed or "stretched" Carboniferous conglomerates of Rhode Island, especially those east of the City of Newport and at Natick. In these it is rarer to have the pebbles break out under the hammer than for the rock to fracture cleanly through irrespective of pebble and cementing material. Not only is this true, but joints, faults and other fractures pass in surprisingly smooth surfaces impartially through pebble and matrix.

It is suggested, therefore, that the term conglomerate be restricted to those pebbly rocks which break through the matrix and around the pebbles after the manner of sandstones. For the type in which fracture is through the pebbles and matrix, analogous to the conditions observed in quartzite, the term *conglomerite* is proposed. This term is suggested because its similar ending to quartzite should make its usage the more ready. Adopting such a term, we would then recognize the three grades of coarse sediments, gravel, conglomerate and conglomerite corresponding to sand, sandstone and quartzite in the next finer series.

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BANANA STOWAWAYS AGAIN

THE discovery of individuals of the genus Marmosa on stems of imported bananas has resulted in several being recorded from the United States.[1] This note presents another record and comments on the conditions under which the mammals may exist before being discovered as well as upon their food habits and the method of carrying the young.

In March, 1928, the writer was asked to identify a "rat" that had been found on a bunch of bananas. The "rat" proved to be a female opossum, genus Marmosa, with two young firmly attached to her mammae. The species was not *M. isthmica,* with which the writer is familiar, but was, possibly, *M. seledoni.*

It is difficult to understand how an animal as delicate as these opossums appear to be could withstand the adverse conditions met in such a trip. Granting that the journey from the plantation to the hold of the ship is not very severe, the survival of the young in a hold the temperature of which is held at 57° F. is remarkable, as this temperature is much lower than that encountered in their native habitat. Moreover, the bananas are green and so are not fit for food.

The specimens that came into my hands not only had survived the voyage from Central America to New York City, but the trip to Albany, seven days in cold storage there and finally a trip by truck to Schenectady. The animal was first seen in Albany, but eluded capture. It was found later on a stem of bananas hanging in a ripening room in Schenectady where the fruit had been taken. On capture the mother and young were placed in an empty candy jar where the writer first examined them. After the escape of the female the two young were preserved for dissection.

The point brought out by Kraatz concerning the food habits is of interest, for one species of the genus, *M. isthmica,* appears to do well on a variety of tropical fruits if they are ripe. One specimen kept by the writer starved to death without attempting to eat coconut or fresh sweet corn and without molesting the two young she had been mothering, and which survived her. Others have been kept for several weeks on banana and papaya. Donato, the Indian overseer, assured me that this species dies if not fed ripe banana, and my experience verifies his statement. With this in view, how do the stowaways survive the trip with apparently nothing to eat but green bananas? Is it possible that they find food of some other sort, insects, for instance? The specimen from Schenectady survived two weeks or more; caged specimens in Panama died in a day or two if not fed.

Young observed in Panama still clung to the female after their teeth had developed and they were not nursing. At this stage of development they clung to the female with their mouths, usually seizing the fur on the sides or on the ventral surface.

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WHEN BELIEVING IS SEEING—AN OPTICAL ILLUSION

DURING a stormy Atlantic crossing not long ago the writer observed a most striking demonstration of the way in which the eye may be aided, or, as in this instance, deceived, by the sense of equilibrium. The ship had been tossing violently for several days and most of the passengers were confined to their staterooms. A group of us, however, were seated one evening near the head of the main stairway. The opposite side of the lounge, seen across the intervening open space of the stairway, quite obviously rose and fell with the motion of the boat, as we, in the group of observers, alternatingly rose and fell.

After watching the apparent motion in an absent-minded way for some time it occurred to the writer to question it and to endeavor to ascertain how this visual impression of motion was registered. How were our eyes able to gauge the movement? By what was it measured? Motion can be "seen" in any one of several ways, but in each case an adjustment of the eye muscles is involved, and this adjustment defines the character and the direction of the movement. We braced our bodies and chairs against the movement of the boat. Our heads were held rigid and our eyes fixed upon a certain point to avoid any muscular adjustment to actual movement on the opposite wall. In spite of every precaution the wall of the saloon opposite to us still obviously rose and fell, see-saw fashion, as our bodies traveled in the opposite direction.

A careful examination of all visible portions of the room and stairway revealed no moving or swaying objects. The night was inky-black outside, with no sign of a light at sea to mark the horizon. Yet the motion continued to be so "visible" that it was hard to believe that no change of focus was necessary in following it. The conclusion to which we were finally forced was that when our semicircular canals registered motion for ourselves, in a certain direction, our minds, receiving this message, passed on to our eyes a demand for what was logically to be expected of them. They being faithful cooperators obediently "saw" what they were supposed to see at a time when our bodies were being tossed up and down in space. In this case, the thing to be expected was the motion which has been described, of the floor, walls and ceiling of the heaving ship's saloon; so this was what they "saw."

RUTH FULLER STEVENS

ELYRIA, OHIO

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[1] SCIENCE, February 24, 1928; April 20, 1928; March 14, 1930.

REPORTS

THE WESTERN COOPERATIVE OIL SPRAY PROJECT (1929)

INTRODUCTION

OIL sprays have been used as insecticides for a number of years. However, the selection and preparation of early oil sprays were not standardized. In consequence of variable results obtained in commercial and experimental use, oil spray applications were attended with considerable risk and with marked uncertainty of effect. A meeting of entomologists and chemists was held at Tacoma, Washington, in June, 1926, to consider the variables encountered in connection with the use of oil sprays and to formulate plans for a concerted and coordinated attack on the problem. At this time an organization known as the Western Cooperative Oil Spray Project was formed.

At first, only entomologists and chemists participated in the project, bringing about a close cooperation between the agricultural experiment stations of California, Idaho, Montana, Oregon, Washington and British Columbia, and the U. S. Department of Agriculture. However, since a thorough study of oil sprays could not be made unless the effects of oils in plant tissue were also considered, the scope of the project was later enlarged to include horticulturists and plant physiologists.

Annual meetings are held for discussion of results and to formulate definite plans for further experimental work. This work has now been in progress for four years, and it is the purpose of this article to summarize the more important results obtained. A preliminary report was published in SCIENCE.[1]

This year (1929), representatives of oil refiners, spray manufacturers and other commercial concerns interested were called in conference immediately following the annual meeting. The results of experimental work with oils were discussed, and the commercial interests unanimously agreed to cooperate with the experiment stations by making their products and recommendations conform to the findings of investigational work. It is believed that a marked benefit will result from this cooperation.

DORMANT OIL SPRAYS

Oils for dormant use have repeatedly demonstrated their value as a spray treatment for San José scale, orchard leaf-roller, red spider, tree-hoppers, etc. It has been found that a lubricating type of oil with a viscosity range of 100 to 220 seconds Saybolt is satisfactory for dormant use. High refinement of oils for dormant use is not necessary since those with a sulfonation test of from 50 to 85 have proved safe when properly emulsified and applied.

The emulsifier used in oils during this period is an important factor from the standpoint of plant injury. While the emulsifier in itself has no injurious effects, the size of the dispersed oil droplets and the stability of the emulsion produced by the emulsifier influence the amount of oil that is deposited and retained on the plant. Quick-breaking emulsions have been found to cause severe injury to trees if applied during a critical period of bud development. This period may be said to exist from the time the buds first show green until the cluster buds separate. While quick-breaking emulsions have given better control of insects in laboratory tests, these differences have not been evident generally in field tests. Therefore, it has been suggested to manufacturers that more stable emulsions be placed on the market.

The time of application of oil was found to be a most important factor. All the oil sprays tested were used with apparent safety if applied before the bud scales separate, even when applied as early as January 15 and when sub-zero weather was encountered following application. However, considerable injury followed the application of quick-breaking emulsions and slight injury from the use of stable emulsions if the application was made during the critical period mentioned above. This is particularly true of trees of the winesap variety or of trees of low vitality.

SUMMER OIL SPRAY

Highly refined oils for summer sprays have proved to be very effective in the control of such insects as red spiders, newly hatched scale, etc. Oil sprays in combination with lead arsenate have also given improved control of the codling-moth. In this combination the oil has a definite ovicidal value while at the same time it increases the larvicidal value of the lead arsenate. Oils in combination with nicotine sulphate have also proved effective in controlling codling-moth, red spider, aphis, etc.

Oils have been studied with respect to volatility (either from the standpoint of evaporation or from the distillation ranges), viscosity and degree of refining or unsulfonatable residue. One property is often conditioned or determined by another so that they can not be varied independently and it is difficult to arrive at a valuation of their effects separately.

In the oils used, the viscosity range varied from 50 to 120 seconds Saybolt. Toxicity for insects within this range was found to increase with viscosity. At a viscosity of 50 seconds oils were relatively ineffective against red spider and codling-moth unless the concentration of the spray was increased considerably. On the other hand, injury to plants was found to increase with an increase in viscosity of oils above 70 seconds. It becomes necessary, therefore, to select an oil with an intermediate viscosity. It has been found that oils having a viscosity range of 65 to 75 seconds are generally satisfactory when used in a limited number of applications, although certain apple varieties (such as the yellow Newtown) are susceptible to injury from oils with viscosity above 55 seconds.

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[1] SCIENCE, 67 (1744): 560–561, June 1, 1928.

The degree of refinement of the oils was found to be another important factor in avoiding injury to plants, although even the most highly refined types sometimes produced injury. Whether this injury is due to oxidation of the oil or to the inability of the plants to tolerate absorbed oil of medium to heavy viscosity within its tissues has not been definitely determined. It has, however, been determined that the carbohydrate metabolism of leaves and vegetative spurs may be adversely affected by oil sprays.

With oils refined by the sulphuric acid method, it has been found that those having an unsulfonatable residue of 85 per cent. or more are preferable for use on plants during the growing period. At the present time it appears that oils produced under the liquid sulphur dioxide process of refinement have a greater stability against later oxidation and may therefore have a greater range of safety when applied to living plants. However, further tests are necessary definitely to determine this point.

The type of dispersion of oils in emulsions used during the growing season has not been found to be important where high pressure is used in spraying. This is probably due to the modification in the emulsions produced by the high pressure through the spray guns, reducing the oil droplet size in the less stable emulsions. This probably accounts for the fact that field tests during the last three years have shown but little difference in the insecticidal value of quick-breaking and stable emulsions. Such differences, however, were found in laboratory tests when the oil emulsions were sprayed with atomizers or equipment using low pressure.

Plant injury from summer oil sprays has followed repeated applications of oils having a viscosity range of 70 to 120 seconds. This has resulted in a russeting of the fruit in many cases and in a general reduction in the size of the fruit. It was found that not over two or three applications of such oil sprays could be used if serious damage of this nature is to be avoided.

It has also been found that serious foliage and fruit injury and dropping occurs when oil sprays are applied on trees carrying unoxidated sulphur deposits. The period that must elapse after use of sulphur sprays or dusts before oil sprays can be safely used varies with weather conditions. In hot weather, it is relatively short, but in cool weather it may be as long as sixty days. The Stayman winesap apple is especially subject to this type of injury, but all varieties are affected when it is necessary to use sulphur for fungicidal purposes.

The use of oil sprays late in the summer while heavy deposits of lead arsenate remain on the fruit or the use of medium or heavy oils in combination with lead arsenate late in the summer was found to complicate seriously the problem of spray residue removal. In some cases it has been impossible to clean such fruit satisfactorily. However, where not more than two applications of oil spray are made in combination with lead arsenate for the first brood of codling-moth or where the nicotine-oil combination without lead arsenate is used for the second brood of codling-moth, the arsenical residue problem has not been seriously complicated.

R. H. Robinson,
D. F. Fisher,
Anthony Spuler, *Chairman*
Publication Committee

SCIENTIFIC APPARATUS AND LABORATORY METHODS

SEDIMENTATION TUBE FOR MECHANICAL ANALYSES[1]

In making mechanical analyses of sediments, the dispersal of the constituents is commonly facilitated by shaking with water in bottles for several hours, and the sands are usually separated from the silts and clays by a series of decantations. In these processes, especially if the sample be sandy, it is a time-consuming operation to remove all the sand from the containers in which the sediments were dispersed and decanted. In our work the procedure has been facilitated by dispersing the sediments in glass tubes closed at both ends by rubber stoppers, and by decanting from a sedimentation tube, shown in the accompanying figure.

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[1] This paper contains preliminary results of an investigation on the "Origin and Environment of Source Sediments," listed as Project 4 of American Petroleum Institute Research. Financial assistance in this work has been received from a research fund of the American Petroleum Institute donated by Mr. John D. Rockefeller. This fund is being administered by the institute with the cooperation of the central petroleum committee of the National Research Council. Manuscript received by the editor December 17, 1929.

The dispersing tubes are thirty-five millimeters in diameter and twenty-two centimeters long, and are closed by No. 7 solid rubber stoppers. Their capacity is about 160 cubic centimeters, which permits eighty cubic centimeters of water to be used in dispersing. The sedimentation tube consists of a glass tube which fits into a glass cup by a ground joint. The cup is three centimeters high and the tube nineteen centimeters, and both are made from forty-millimeter tubing. The ground joint is fifteen millimeters in length, and if the tube is twisted firmly into the cup the apparatus will not leak, even after standing full of water for several days. A hole in a wood block is used for a support, but the cup can be made with a base so that it will stand of itself.

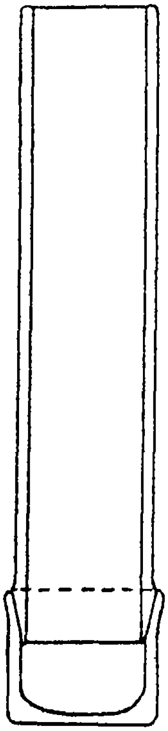
FIG. 1

The sediments are transferred from the dispersing tube to the sedimentation tube by removing one rubber stopper, inserting the dispersing tube into the inverted sedimentation tube, righting the whole apparatus, removing the other rubber stopper and washing with a stream of water. The silts and clays are decanted from the sedimentation tube, the cup in which the sands have collected is removed from the tube and the sands are readily washed out from the cup with a jet from a water bottle. The whole process is simple and very rapid. In fact, other processes involving decantation could probably be facilitated by a sedimentation tube of this type.

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STOCK CULTURES OF AMEBA

IN the course of experiments in this laboratory it has been necessary to maintain cultures of *Ameba proteus* in stock. The writer endeavored to find a medium that made requisite a minimum amount of attention. The effort in this direction met with considerable success, as appears below. In view of the wide use of *Ameba* of the *proteus* type in biological research and elementary instruction in biology, a culture medium that is simple, reproducible and extremely reliable will be of general interest. The medium used is as follows:

NaCl	0.1	gr.
KCl	0.004	gr.
$CaCl_2$	0.006	gr.
H_2O	1000	cc (glass distilled)

Two hundred to 250 cc of this solution is put into a finger-bowl or glass crystallizing dish of 8 or 10 cm diameter and to each of such dishes is added 4 or 5 grains of polished rice (any brand carried at the corner grocery is suitable). The cultures thus prepared are immediately seeded with fifty to one hundred amebas, covered with glass plates to prevent evaporation and entry of dust and then left, best in a dark cool place, to develop. Such cultures will produce a fine crop in from two to four weeks and so far in some thirty or forty cultures the writer has had only one or two failures. There are at present on the shelves of the laboratory, out of five that were set up as a test, three cultures one year old that have ample numbers of amebas; the other two died out in eleven months.

These five cultures during their existence have been deliberately neglected. No detritus was removed. Rice was added only when it was noticed that none was apparent in the culture. Water too has been added to compensate for evaporation with no attempt at regularity, say, on the average once a month. The temperature variation has been from 19 to 28° C.

In other words, the cultures have been subjected to as careless handling as if in the hands of a somewhat below par student assistant, but they have survived.

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SPECIAL ARTICLES

THE CHEMICAL CONTROL OF SPLENIC CONTRACTION

THE behavior of the spleen in responding to different physiological requirements and the fact that this response occurs only when its nerve supply is intact[1] suggests control by some center. At times when there is an emergency call for hemoglobin, as in asphyxia, hemorrhage or severe muscular exercise, contraction of the spleen throws into circulation a large number of red blood cells, as many as one third the total number in the body.[2] When the period of stress is over the spleen relaxes and the excess red blood cells are withdrawn from circulation. The regulatory nature of the reaction and the character of the stimuli which set it off suggest at once a parallel with the action of the respiratory center. The stimuli acting on the respiratory center are (1) variation in the CO_2 pressure in the blood, (2) lack of O_2, (3) increase in the H-ion concentration of the blood, which in the normal animal is chiefly brought about through the presence of lactic acid. According to Gesell's now well-known theory, excitation of the cells in the respiratory center is the result of a shift in the equilibrium between these cells and their environment. It is evidently the change in the H-ion concentration within the cells which is the all-important internal factor, and because of its penetrating power CO_2 may be considered the chief environmental factor.

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[1] E. A. Schäfer and B. Moore, *Journ. Physiol.*, 20 (1): 1–50, 1896.

[2] E. H. Starling, "Principles of Human Physiology," fifth edition, p. 820, 1930.

We have determined the effect on the spleen of these three stimuli: (1) *increase* in CO_2, (2) *decrease* of O_2 and (3) addition of lactic acid to the blood. For this purpose we have employed curarized, decapitate cats,[3] recording changes in the area of the spleen by tracing its outline on glass plates.[4] The advantage of such a preparation is that with the entire brain gone there can be no effect from emotional states, such as is seen in animals with exteriorized spleens,[5] or from muscular movements such as occur in decerebrate preparations,[4] both of which conditions would cause fairly rapid changes in the size of the spleen and confuse the issue. Furthermore, the administration of different gas mixtures is readily possible because of the necessity of supplying artificial respiration. This in itself is an added advantage because constant ventilation is assured regardless of the nature of the gas mixture, a condition which would certainly not obtain were the animal breathing on its own with medulla intact.

(1) A mixture of 4.8 per cent. CO_2 in O_2 caused a 10 per cent. reduction in the area of the spleen within five minutes (three experiments). There was no further significant change after ten minutes or even twenty minutes. Seven per cent. CO_2 in O_2 gave exactly the same results (five experiments). Eleven and eight tenths per cent. CO_2 in O_2 caused a 20 per cent. reduction in five minutes, and 30 per cent. within ten minutes, practically the maximum contraction or the post mortem condition (four experiments).

Similar results were obtained when the CO_2 was mixed with air instead of O_2. Two and one half per cent. CO_2 in air produced no significant change (two experiments). Five and six tenths per cent. CO_2 in air caused in five minutes a 10 per cent. reduction in the area of the spleen, with no further change after ten minutes or twenty minutes (three experiments). Ten and five tenths per cent. CO_2 in air caused a 14 per cent. reduction in five minutes (two experiments). Although fourteen different cats were used in the nineteen experiments, there was excellent agreement of the data and no experiment gave results contradictory to those of the others.

(2) Administration of 9 per cent. O_2 (three experiments) or even 5.1 per cent. O_2 (four experiments) *in* N_2 had no effect on the size of the spleen even after twenty minutes. The post mortem contraction following death by asphyxiation was normal in each case, therefore lack of response to lowered oxygen tension could not have been due to inability on the part of these spleens to respond to an adequate stimulus.

(3) Human blood may contain after severe muscular exercise as much as 0.12 per cent. lactic acid, or in exceptional cases 0.20 per cent.[6] If we consider the blood to constitute 7 per cent. of the body weight, then injection of 140 mgm lactic acid per kilo body weight would correspond to the exceptional cases, and injection of half this amount would correspond to the effect of severe exercise. The latter dose therefore should be sufficient to bring about contraction of the spleen if the lactic acid produced during muscular exercise is an adequate stimulus for such contraction. In order to affect the heart as little as possible and to prevent too great hemolysis of the blood by the sudden addition of a comparatively large volume of acid, we injected the requisite amount of 5 per cent. lactic acid sometimes directly into the femoral vein, and at others into a small side branch opening into the femoral vein, very slowly, *i.e.*, over a period of about two minutes. We found that when the larger dose was given the animal died immediately and the spleen contracted at once to its post mortem size (two experiments). On the other hand, when the lighter dose was given there was no change in the size of the spleen, and the preparation remained alive and in good condition (three experiments). In one case half an hour after the injection of 70 mgm of lactic acid per kilo, the size of the spleen having remained unchanged, 10.6 per cent. CO_2 in air was administered. The area of the spleen now diminished by 15 per cent. in 5 minutes, exactly as in the untreated preparation. In the other two cases the post mortem contraction was normal.

It should be emphasized that in this paper we are dealing only with the chemical stimuli affecting the adjustments of the spleen. Stimuli from the emotional (higher) nerve centers together with the action of epinephrine cause profound changes in the size of the spleen.[5] Similarly emotion and volition may override, at least temporarily, the action of the respiratory center.

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[3] S. F. Cook and J. M. D. Olmsted, *Am. Journ. Physiol.*, 92 (1): 249–252, 1930.

[4] S. F. Cook and M. I. Rose, *ibid*, 92 (1): 240–248. 1930.

[5] J. Barcroft, *Journ. Physiol.*, 58 (4): 375–382, 1930.

[6] A. V. Hill, "Muscular Activity," p. 87, 1926.

The nervous mechanism controlling the action of the spleen in mobilizing reserves of hemoglobin responds therefore to only one of the three chemical stimuli which are effective for the respiratory center, *viz.*, increase in CO_2, but it is to be noted that this particular stimulus has been shown in the latter case to be by far the most important of the three. In fact, CO_2 is regarded as the "normal respiratory stimulant." In man, at any rate, the respiratory center responds to an addition of as little as 0.8 per cent. CO_2 to inspired air,[7] whereas in our experiments 2.5 per cent. CO_2 was ineffective on the spleen. It is perhaps to be expected that the control of the spleen should be less sensitive than the control of respiration, for the action of the spleen is an emergency one and is called into play under stress, whereas the respiratory center acts as a constant regulator and consequently must be able to respond to relatively small changes.

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THE CHEMICAL NATURE OF CYPRIDINA LUCIFERIN

The nitrogen content of Cypridina luciferin is one of the most essential factors in deciding whether it is a protein or not. Luciferin isolated by my former method[1] contains about 4 per cent. of nitrogen, whereas luciferin isolated by my recent method[2] contains about 6 per cent. of nitrogen, as shown in Table I. This variability in quantity of nitrogen content is not clear, although the degree of purity of luciferin isolated may be supposed to be one cause. If so, the precipitation of luciferin with ammonium sulphate may act more selectively than when benzene dissolves it. Either of these amounts of nitrogen content is, however, too small for a protein. In this connection, it should be borne in mind that luciferin isolated by both my methods gives no protein color tests.

TABLE I

Nitrogen Content of Cypridina luciferin*

Isolated by two methods		Former	Recent
	Exp. 1	3.58 per cent.	5.84 per cent.
One sample	" 2	3.74 " "	5.87 " "
	" 3	3.85 " "	6.04 " "
Average		3.72 " "	5.91 " "

* For all the determinations of nitrogen I am indebted to Mr. Shigeo Okido.

I have also found that Cypridina luciferin isolated by the two methods contains a large amount of phosphorus.[3] On the other hand, Witte's peptone, which chiefly consists of proteoses,[4] and Merck's peptone are found to contain phosphorus. In respect of phosphorus content, Harvey's belief[5] that Cypridina luciferin is a proteose or peptone seems to be favored. But this is not the case. Neither Witte's nor Merck's peptone is soluble in benzene, chloroform, ether, etc., as would be expected, whereas Cypridina luciferin is readily soluble in these solvents. These solubility relations of luciferin entirely refute the idea of Harvey.

The evidences from these triple experiments of nitrogen and phosphorus contents and solubility indicate that Cypridina luciferin is of a chemical nature similar in type to that of phospholipids and in particular to that of lecithins. The amount of nitrogen contained in luciferin isolated by my methods, however, is too much for a lecithin in the present state of purification.[6] We should, therefore, direct our research to the discovery of a pure luciferin, as pure as a phospholipid.

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BOOKS RECEIVED

Adam, Neil. *The Physics and Chemistry of Surfaces.* Pp. x + 332. 45 figures. 20 tables. Oxford University Press. $6.00.

Belling, John. *The Use of the Microscope.* Pp. xi + 315. 28 figures. McGraw-Hill. $4.00.

Betts, Charles T. *Aluminum Poisoning.* Pp. xxxiii + 212. 10 illustrations. Research Publishing Company.

Castellani, Aldo. *Fungi and Fungus Diseases.* Pp. 203. 89 illustrations. American Medical Association.

Silberstein, Ludwik. *The Size of the Universe.* Pp. viii + 215. 11 figures. 6 tables. Oxford University Press. $3.50.

Sommerville, D. M. Y. *An Introduction to the Geometry of N Dimensions.* Pp. xvii + 196. 60 diagrams. Dutton. $3.90.

Van Buskirk, Edgar F., and Edith L. Smith. *The Science of Everyday Life.* Pp. xviii + 620. 303 illustrations. Houghton Mifflin. $1.60.

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[7] E. H. Starling, *op. cit.*, p. 875.

[1] S. Kanda, *Am. Journ. Physiol.*, 68: 435–443, 1924.

[2] S. Kanda, *Sci. Pap. Inst. Phys. Chem. Res.*, 10: 91–98, 1929; also *Chem. News*, 138: 247–248, 258–260, 1929.

[3] It was recently found that the luminous organs of the larva, pupa and adults of the Japanese firefly, *Luciola cruciata* (*vitticollis*), contain phosphorus.

[4] A. P. Mathews, "Text-book of Physiological Chemistry," 1927, p. 992.

[5] E. N. Harvey, *Journ. Gen. Physiol.*, 1: 269–298, 1919; *Bull. Nation. Res. Coun.*, 59: 50–62, 1927.

[6] Cypridina luciferin isolated by any methods contains some sulphur, which may be one of the impurities.

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HOW STATE ACADEMIES OF SCIENCE MAY ENCOURAGE SCIENTIFIC ENDEAVOR AMONG HIGH-SCHOOL STUDENTS[1]

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I shall present four aspects of the problem of encouraging scientific endeavor among high-school students: a glimpse of the trends of the high-school curriculum as they bear upon proposals for cooperation by the state academies of science; an outline of the efforts of the Illinois State Academy of Science to encourage scientific endeavor among high-school students; a statement, as requested, of personal experience related to science clubs, and suggestions as to possible benefits if other state academies of science develop similar projects in their high schools.

Concerning the curriculum, it is apparent that old subject-content, standards, methods and results are not entirely satisfactory. Here, as elsewhere, philosophic and scientific studies are producing change. One who has been called "the greatest educational leader of our time, and perhaps all time,"[2] says in stating his theory[3] that the life of the school is to be active, not passive; that the children are to work, not merely to listen, that the curriculum is to be organized around the chief impulses, which are the social instinct of the children, the constructive impulse, the expressive instinct and the impulse toward inquiry or finding out things. So far as the average high school has learned to make use of these impulses, it has been through the so-called extracurricular activities.[4] McKown says: "Extra-curricular activities must be built upon the broad principle that the school is a laboratory for citizenship, and whenever possible the situation in the school should resemble the situation which the future citizen will face." Such activities should be recognized and made a regular part of school life and work.

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[1] This paper has been condensed from the paper read before the representatives of the State Academies of Science meeting with the American Association for the Advancement of Science, Des Moines, Iowa, December 27, 1929. The representatives voted to request the chairman of the American Association committee on the place of science in education to cooperate in revision and in arranging for the publication and distribution of the paper. Copies of this paper may be secured from the office of the permanent secretary of the American Association for the Advancement of Science, Smithsonian Institution, Washington, D. C., or from the chairman of the association committee on the place of science in education, 433 West 123rd Street, New York City.

[2] R. A. Kent, "Leadership," *Phi Delta Kappan*, XII, 2: 40, August, 1929.

[3] John Dewey, "School and Society," p. 11, University of Chicago Press, 1899.

The science club offers a master key to scientific endeavor among high-school students. The state academies can foster science clubs in high schools by offering the mutual advantages of affiliation between the clubs and the academies. From such affiliations each member of the junior organizations, through such association, may be led to sense the power that science is wielding. There are not less than four million students of high-school age available to organization and leadership. These four million and those to follow will need to know, more than the pupils before them needed to know, all that science can impart to them and open to them for their own opportunities.

The magnitude of the science club movement throughout the country was shown by Dr. H. A. Webb,[5] who compiled data on 146 science clubs in 28 states and found a total enrolment of 5,608 students. In the State of Illinois there are approximately 700 four-year high schools which are officially accredited or have applied for accrediting. Of these there are 290 which are on the approved list of the North Central Association of Colleges and Secondary Schools. The total enrolment of these 700 Illinois schools is approximately 270,000; the average enrolment is approximately 387. In those 700 schools, not less than 67,500 students are enrolled in science courses. In the average Illinois high school a minimum of 96 students is enrolled in science courses. Now, if each school should have one science club, 700 high schools would have 700 potential science clubs. Or, since the 290 four-year high schools bearing the approval of the North Central Association of Colleges and Secondary Schools represent the best that Illinois has in the matter of standards, the Illinois State Academy might reasonably anticipate affiliation of from 290 to 700 science clubs. The Illinois State Academy of Science began fostering and affiliating high-school science clubs in 1919. It has affiliated clubs from 18 different schools. If the number of years during which each club has maintained affiliation be added together, there are 51 year-units of high-school club affiliation with the Illinois State Academy of Science. It is believed that a similar program operating through all state academies of science would be possible. Organization, detailed information and wise stimulation were found to be essential prerequisites on the part of the academy. Character, initiative and other leadership qualities are essential requirements of the local sponsors. Cooperation is the chief essential to be contributed by the local school administrations.

The work of the science club should be a regular and important part of school life, and not an extra piece of work put in at the end of the day or week as an activity unrelated to school work.

The Illinois academy has affiliated scientific societies other than high-school clubs. These society affiliations may have definite relationships to the high-school clubs. They may have addresses or other programs of general interest. Invitations from the societies to the high-school clubs in the community or section of the city represent a salient method of stimulating interest in clubs of secondary schools. Also the affiliation of these societies represents one thing the academies may do toward adult education, which it seems must sometime involve the whole of our educational system. The tabulated data on these societies show that society organizations in terms of maintained affiliations are the more stable. This stabilizing and constant good influence is wholly desirable as far as the high-school science clubs are concerned.

Difficulties regarding high-school affiliations are due, in part, to the following causes:

In the development of the so-called non-academic subjects, including athletics, the classroom instructors lost much of their earlier influence in extracurricular activities. Discussion societies and dramatic clubs, which formerly represented the most activating type of extracurricular work, came to be of little consequence as a means of motivating the student in the average high school. This situation arose partly because the average instructor of academic subjects was not well prepared to match the influence of his personality and work against so many powerful factors outside the classroom. Then, there came to the high school hordes of children who did not possess a background of scholastic interest. It is a salutary thing that science, in continuously extending privileges to man's ability, is among the first in the academic field to use concerted action toward appreciation and information through such agencies as science clubs and societies.

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[4] Harry C. McKown, ''Extracurricular Activities,'' p. 9, Macmillan, 1927.

[5] H. A. Webb, ''Some First-hand Information concerning Science Clubs,'' *School Science and Mathematics*, 29: 273–76, March, 1929.

Secondly, the science instructor must meet outside influence by offering genuine and lasting values to all those whom he expects to motivate. The instructor must be a salesman[6] of the highest order. With proper incentives and dependable working tools he will produce the desired results. These incentives and tools should be derived from at least three sources: the teachers' training course, teachers' conference meetings and state and national organizations. Interest on the part of science instructors is increasing. Requests for information of various kinds relative to club work have come from many states and from Canada. It is desired that the state academies work through these teachers' training courses and teachers' conferences. Such plans require time and tact for their development. The quality of the personnel of committees is essential to success of even carefully developed plans. Not only these state committees but also the local club sponsors are vitally important in the success of the movement.

At the Jacksonville meeting, J. L. Pricer,[7] then state secretary, concluded his report as follows:

> Education in science is so vital to the general welfare of every phase of science that it seems to me that every member of the academy should have some interest in the problems of science education in the secondary schools. Therefore, I believe that the academy should have a permanent committee of three on science education in the secondary schools. It should be the function of this committee to make annual reports to the academy on the status of secondary school science, and on occasion to call on the academy for cooperation and help in the solution of certain problems.

In 1922, the president was empowered to appoint a committee of five, to be called the committee on high-school science and clubs. This committee took the place of two former committees, the committee on secondary science and the committee on high-school clubs. This committee has separate chairmen for high-school science and for high-school science clubs. These chairmen work together with the whole committee on the various problems they have to consider. It is my opinion that the compact committee of those responsible for cooperation with high schools represents a very efficient arrangement. In 1926[8] the committee decided to confine its activities to presenting a series of programs in the high-school section of the annual academy program, for the purpose of encouraging the formation of science clubs. With the demonstration of more tangible values no clubs were lost during the next two years and there have been gains each year, until at the present time there are more clubs than at any time in the history of the movement. The Danville Science Club has held affiliation continuously for nine years. Last spring, for the annual meeting at Macomb, several car-loads of high-school delegates, bearing their scientific exhibits, traveled across the length and breadth of the state to enjoy the dynamic program arranged for them. This included a stirring lecture on the opportunities in science to-day by Professor B. S. Hopkins. There were films and reports on the activities of the various clubs, as well as judging of exhibits. The most stimulating feature of the business meeting was the adoption of a standardized pin and guard to be worn by the student members of all affiliated clubs in the state.[9] That evening, preceding the popular lecture, a chemistry play[10] by college students was presented through the courtesy of the Western Illinois State Teachers College. The privilege of taking six representative high-school delegates on that 450-mile trip to such an inspiring program represents an opportunity in leadership and service which is an outstanding thing in my teaching experience.[11] Out of the success of that trip has arisen the community project of providing for transportation for high-school delegates to the annual meeting of the academy.

To aid sponsors and clubs in organization as a step toward affiliation, the Illinois academy has authorized the preparation and distribution of literature. An eight-page printed pamphlet[12] has been useful. It contained a model constitution, sample programs, information on the significance of science and on the importance of affiliation with the academy. It also included addresses given by the committee members. One of the publications recommends automatic perpetuation of the club through the election of officers at the end of a year rather than at the beginning of the next year. If, then, there is the somewhat common change in sponsorship or administration the science club has a greater chance of surviving. Another practical suggestion is the development of a model constitution for the junior academy of science, with provisions for state officers to be selected from the high-school students in affiliated clubs. Another suggestion is that detailed program outlines found to be successful because of their dynamic, educational and general values should be compiled and distributed together with program references in current literature.[13] The program data should include the names, sources and ratings of films, slide sets and film-slides used in connection with these programs. The average teacher will appreciate such carefully developed service. He will need to recognize, of course, the sociological importance of imitation as applied to the students' action. In the same manner he will need to take cognizance of the psychologically valuable principle of self-expression. And he must reckon with the pedagogically valuable advantage of student participation in the social events and consciousness of the surroundings. All these things need to be understood by the instructor, but he does not need to be a master in these fields nor does he need to have a personal library of special information in order to get good results.

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[6] A. L. Turnbull, "The First Great Salesman of Science," *Popular Science*, 109: 25, September, 1926.

[7] J. L. Pricer, "Secretary's Report," *Transactions of the Illinois State Academy of Science*, XII: 17, 1919.

[8] F. C. Phipps, "Report of Council Meeting," *Transactions of the Illinois State Academy of Science*, XIX: 11, 1926.

[9] L. A. Astell, "A Ritual and Other Devices for High-school Science Clubs," *School Science and Mathematics*, 27: 952–955, December, 1927.

[10] R. D. Billinger, "A Night in Alchemy," *Journal of Chemical Education*, 5: 715–24, June, 1928.

[11] L. A. Astell, "Fostering Science Clubs in the High School," *Journal of Chemical Education*, 6: 496–501, March, 1929.

[12] "A Message to High-school Science Teachers and Students of Illinois from the Committee on High-school Science and Clubs." The chairman of this committee was Dr. J. C. Hessler, of Knox College.

The idea of fostering the spirit and methods of science through a knowledge of our great men of science has not been developed as fully as desired. Relatively few clubs at the present time have honored scientific achievement in this way. The requirement that candidates pass a written initiatory examination on the life of the chosen scientist whose name has been selected by the club is a valuable aid. The presentation of films or other types of visual aid materials regarding the life and work of the chosen scientist is another deserving method, particularly if accompanied by good talks. This year, on the night of "Light's Golden Jubilee," the Edisonian Science Club of West Chicago held its initiation. The formal part included slides and accompanying remarks concerning the great benefactor. Then, in the hush of anxious moments, the re-created voice of Edison, himself, as it was broadcasted from Fort Dearborn, swept into the auditorium. To have been initiated into this club on the fiftieth anniversary of the incandescent lamp is a memory to be treasured. Who could forget that privilege? What an incentive for emulating Edison's painstaking methods! What an urge for duplicating his production in any small part!

The academy can help further by placing the high-school club section of the academy's annual program at such time as to avoid conflicts with the important and popular features of the general program. The Illinois academy, for example, no longer has the club section meeting on Saturday morning, which is the time for the customary field trip. Another factor in the success of clubs is the lecture service. The constitutions I have used have required that the clubs bring or assist in bringing to the community at least one good scientific lecturer each year. No large amount of work has yet been done by the Illinois Academy of Science in the direction of free lecture service. Thus far the academies have discharged this function through the careful selection of speakers for the annual program. The appointment and endorsement annually of lecturers for high-school clubs at a minimum of expense to the individual club may become desirable. Even though the academy were to develop some means to defray a major portion of the expense, this seems more practical than calling for volunteers to give gratis lecture service. The high-school students would obtain further value from the idea that these lecturers represent the state academy with which their club is affiliated. On the same basis the lecturers should be able more effectively to encourage scientific endeavor in the youthful audiences.

Where the academies are unable to render lecture service to the affiliated clubs the following alternatives are offered. First, the academies can distribute gratuitously, or otherwise, such admirable reprints as Dr. Little's "The Fifth Estate." These reprints should be selected with a view toward utilization as student reports in the club programs. Such material is not commonly found in the average high-school library. Second, the academies can send out reference sheets on scientific lectures, which after all are to be found in considerable numbers[14] under conditions not difficult to meet by the average club. This has never been undertaken by the Illinois academy, but it is recognized as a practical and inexpensive service. The academies can encourage the clubs by distributing or listing references to novel, distinctive and purposeful initiation ceremonies.[15]

It will be noted that none of these suggestions entail extensive machinery on the part of the individual state academies. Nearly all the suggestions are already in practice in Illinois. Teachers perhaps are too often concerned with receiving rather than rendering service, but it seems that the psychology for obtaining useful affiliations is not greatly different from that of obtaining added club memberships, that is, by having the academy demonstrate its service to the affiliated clubs.

How does the principle of encouraging scientific endeavor among the high-school students through the state academies find application? First, there will be an application to a single student; then to the club as a whole as shown by a comparative outline of annual reports; then the work of certain progressive clubs will be presented; then the concluding remarks.

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[13] "Program, Edisonian Science Club, West Chicago Community High School, West Chicago, Ill.," *School Science and Mathematics*, 29: 1929.

[14] The School Assembly Association, 1309 Kimball Building, Chicago, Illinois, and the Bureau of Commercial Economics, Department of Public Instruction, Washington, D. C., are examples.

[15] W. M. Lamar, "The Fraternity Initiation," A one-act burlesque, *Journal of Chemical Education*, 6: 2254–59, December, 1929; L. A. Astell, "Initiation Ceremony of the Edisonian Science Club," *School Science and Mathematics*, 28: 771–4, October, 1928.

Some time ago, a boy was discovered making, voluntarily, day-by-day clipping record of Commander Byrd's work in the Antarctic. What school hasn't a boy who has been doing that! In conversation with the boy it was found that he had studied the North Pole achievement as completely as the libraries at his command permitted. These libraries were above the average on account of the environment and suburban location. The boy had made a study of the personal life of Commander Byrd. The teacher's opportunity for encouraging scientific endeavor was plainly shown. The idea of a "Pole to Pole" theme program came into being. Two reels of Commander Byrd's North Pole flight were located.[16] What audience would not thrill at the thought that before their eyes were reflected the very pictures that Byrd had taken during the flight, as the now-lamented Bennett piloted the plane known as the *Josephine Ford* above the barren and untracked wastes to a new victory for mankind? What history! What science! Another reel on Byrd's South Pole preparations was booked from a difference source.[17] The club boy was scheduled to give the half-hour feature-talk as part of the program. A local business man, who had lived in Alaska, was secured to add "native color." Only music and short readings were needed to add the final touch to a program worthy of the attention of any adult audience: What a privilege for the local club members and for the invited delegates from other high-school science clubs! What a feeling of assurance must have arisen in the minds of the club members' parents who were invited to attend this program! What more satisfactory way of encouraging scientific endeavor among high-school students and in the community!

Whatever the form of organization and the nature of the scientific work of the individual club, the end product should be an encouragement of scientific interest and endeavor which the student will not discontinue when he leaves the high school. This is true already, we believe, where delegates have gone to worth-while state academy programs; where these student delegates have their own junior academy organization with their own officers functioning under the senior academy and where the state academies are rendering definite assistance in the matter of organizing and operating the local high-school clubs.

If the efficient management of this detailed service on the part of each state academy appears to be too burdensome, or if there should be too much duplication by the different state academies, there might be a national director who would perform his duties in cooperation with the state chairmen of high-school science clubs. The permanent secretary of the American Association may have had something of this thought in mind a year ago to-day when he spoke of the economic aspects and increased efficiency of circularizing the science workers in each state through the Washington office. If such a director should secure detailed reports from the different state meetings he would possess the basic information necessary for service to each state academy. Useful reprints and other data could be sent to the state chairmen. Such a director's position should place him in command of suitable lecture service to be broadcasted through the courtesy of scientific organizations and companies for the benefit of the individual club organizations. The prestige of that position could be used to assist the affiliation of local high-school clubs and other local science organizations with the larger scientific bodies.

To summarize briefly. The state academies may encourage scientific endeavor among high-school students by establishing the necessary organization, by supplying detailed information and by developing momentum for science clubs as activities concerned with the fundamental academic subjects. The academies may promote this work through such specific actions as: (1) making the necessary constitutional changes of adult societies as well as high-school science clubs; (2) assisting in the development of a constitution for the junior academy; (3) by working through teacher-training courses in science, wherever offered; (4) by obtaining and utilizing to a maximum advantage the periods of time in scientific sections of district, state and national conferences and associations of teachers; (5) by preparing and distributing literature to the local clubs and schools; (6) by fostering the spirit and methods of science through an intimate knowledge of the men of science, and by the use of their names in identification of clubs; (7) by constructing the annual program of the state academy for the maximum benefit to the high-school delegates; (8) by supplying lecture service or reprints and other items of direct use in the local programs; (9) by encouraging the use of such devices as purposeful initiations, cards of credentials and standardized club pins, and (10) possibly sometime by the employment of a national director.

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[16] Pathé Exchange, Inc., 35 West 45th St., New York City.

[17] Motion Picture Bureau, Y. M. C. A., 120 West 41st St., New York City, and 4829 South Kedzie St., Chicago, Illinois.

THE PRODUCTION OF FEVER IN MAN BY SHORT RADIO WAVES

By Dr. CHARLES M. CARPENTER AND ALBERT B. PAGE
RESEARCH LABORATORY OF THE GENERAL ELECTRIC COMPANY, SCHENECTADY, NEW YORK

The value of heat as a physical means of alleviating and curing disease has been emphasized constantly throughout the history of medicine. However, the significance of fever and its relation to the course of an infectious disease or to the healing of trauma has been debated often. It was believed that a rise in body temperature was only a sign of disease, as is pain, and, to establish the comfort of a patient, must be dissipated. Nevertheless, evidence has been accumulated during the last few years to show that a fever, disregarding hyperpyrexia of central origin, may be a phenomenon valuable to the diseased animal body. It is a very complex factor in which an increased amount of heat stored in the body is its chief manifestation. In this report it is impossible to tabulate all the facts substantiating the value of fever in the course of a disease, but we premise that it is a defensive mechanism for the body.

To raise the body temperature of laboratory animals such as mice, rats, guinea-pigs, rabbits, dogs, etc., is comparatively simple. Their mass is small and they are not so able to eliminate effectively an increased amount of heat as is man. They have a hairy coat and do not possess the great areas of sweat glands with such an extensive peripheral vascular bed. However, these factors may make such heatings more hazardous to the life of the animal.

Many investigators have described methods for heating the human body locally or generally. Local heating is easily accomplished, but since man's temperature-regulating mechanism is so efficient the elevation of a normal temperature is comparatively difficult. Because so much time has been required in the past to do this, the therapeutic application of artificial fevers has not been practical. Various physical methods have been employed. Hot water baths have been used successfully by Schamberg and Tseng[1] and by Mehrtens and Pouppirt.[2] Exposure of the body to artificially heated, dry and moist atmospheres has frequently been used in an attempt to raise the body temperature. Recently diathermic methods for producing artificial fevers have been developed. Nagelschmidt[3] as well as King and Cocke[4] have described special apparatus and methods for applying this energy for therapeutic purposes. The latter state that after a rise of one or two degrees during the first half hour or hour, they usually obtained a rise of .6 degrees F. for every fifteen minutes. While the physicist and those engaged in developing physical therapy have been conducting such experiments the bacteriologist and immunologist have also been studying this same problem. For a long time they have known that the injection of a protein, usually foreign, used as a diagnostic agent or as a therapeutic agent, will destroy the equilibrium between heat production and heat loss in the body and result in a fever with other symptoms characteristic of those observed in an acute infectious disease. Combinations of certain diseases occurring in the same individual, *i.e.*, an acute febrile disease with a chronic afebrile malady, sometimes resulted in an improvement or a cure of the latter. Such observations played an important rôle in Wagner von Jauregg's[5] development of the malaria treatment for paresis. Because of his success the study of the value of fever in an infectious disease syndrome is engaging the attention of many investigators. That the heat associated with the febrile phenomenon due to the injection of a protein is the factor that is responsible for the beneficial results is suggested by the favorable results obtained in the treatment of neurosyphilis by heat alone. The present methods that are used to establish fever in man are unsatisfactory in one respect or another. The injection of foreign proteins is hazardous because one is dealing with unknown factors and uncertain quantities. The use of Plasmodium malariae or spirochaetes for the treatment of general paresis often fails because of the danger concerned with the administration of a living virus and because of a failure to infect immune individuals. The physical methods employed are time-consuming, difficult of application, not easily controlled and, to a certain degree, dangerous.

Since the observation of Dr. W. R. Whitney, director of the research laboratories of the General Electric Company, that there is an elevation of the body temperature of men working in the field of a short wave radio transmitter, considerable experimental work has been undertaken to adapt this energy for producing artificial fevers. Hosmer[6] has reported these heating effects on salt solutions of various concentrations and on small laboratory animals. She determined that this is a method for producing in animals any degree of fever at will without the introduction of foreign substances. The heat is produced directly within the animal body, as occurs in the course of a fever due to an infectious disease. This constitutes a method for internal heating in which the heat is generated in the organs of the body as rapidly as in the body walls, but because of the greater heat loss at the periphery the temperature of the internal tissues rises more rapidly.

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[1] Schamberg and Tseng, *Am. J. of Syphilis*, 11: 337, 1927.

[2] Mehrtens and Pouppirt, *Arch. Neurol. and Psych.*, 22: 700, 1929.

[3] F. Nagelschmidt, *Deutsch. Med. Wchnr.*, 54: 2102, 1928.

[4] King and Cocke, *Southern Medical Journal*, 23: 222, 1930.

[5] J. Wagner-Jauregg, *Psych.-Neurol. Wchnr.*, 20: 132, 1918.

[6] H. Hosmer, Science, 68: 325, 1928.

During the last two years special types of apparatus have been designed by the research laboratories of the General Electric Company and used experimentally in an endeavor to cause a fever in man rapidly without great discomfort to the patient and to a degree high enough to be of value. The equipment used in our experiments has been constructed on the same principle as a short wave radio transmitter, with the exception that the energy is concentrated between two condenser plates instead of being directed from an aerial. The heater consists of a vacuum tube oscillator and a full wave rectifier that supplies the high voltage for the oscillator. The high frequency oscillator is composed of two 500 watt radiotrons operating at a frequency of from 10,000 to 14,000 kilocycles, the output of which is concentrated between two plates. The rectifier is an oil immersed transformer having a 7,000 volt secondary and feeding two half-wave, hot cathode, mercury vapor tubes. In conjunction with a filter system this unit furnishes the 3,000 volt D. C. plate supply for the oscillator. An auto-transformer is connected on the primary circuit of the high voltage transformer to provide plate voltage regulation.

The condenser plates are of aluminum, 28″ by 18″ by ⅛″, and are covered with hard rubber plates 30″ by 20″ by ¼″ to prevent arcing should the patient or attendant come in contact with the plates. In this field of undamped waves between the plates there is a rapid alternation of 3,000 volts drop of potential. We have obtained our greatest heating from the use of a 30 meter wave that oscillated 10,000,000 times per second between the plates. We have used wavelengths of 6, 15 and 18 meters, but they have not heated the body so effectively with the oscillator described.

The patient is suspended on interlaced cotton tapes stretched across a wooden frame 76″ by 28″ made of two by sixes. The under surface of the frame is covered with celotex one half inch thick, forming an air chamber beneath the body. A celotex cover of similar thickness, 8 inches high and one foot shorter than the frame, is fitted over it so that the head of the patient projects through an opening at one end. Thus there is formed a fairly tight air chamber around the body as it lies on the tapes. The patient rests on his back and the plates are placed at each side of the celotex box, so that the waves oscillate through the body from one side to the other. The plate distance can be varied, but as a rule has been kept at 30 inches. Two small hair driers are placed in openings at the foot, one above and one below, to circulate hot air around the body. These decrease heat loss and equalize the humidity throughout the enclosed atmosphere.

By applying the plates in this manner and by enclosing the body, it is heated rapidly without causing great discomfort to the patient. We have raised the normal rectal temperature of 99.6 degrees F. to 104 degrees F. and 105 degrees F. in from sixty to eighty minutes. In one instance a temperature of 106.5 degrees F. was recorded. Higher temperatures may be obtained easily with the apparatus employed, but, because of our limited experience, we have proceeded cautiously. When the desired temperature is reached it may be maintained in several ways: First, by decreasing the voltage; second, by increasing plate distance; third, by employing only the hot air blowers.

The temperature recedes very slowly to normal if the patient is allowed to remain in the box or if he is removed from the box and wrapped in heated, heavy woolen blankets, which is more comfortable for him. There is, of course, an increase in rate of pulse and respiration which, in general, corresponds to the rise in temperature. The patients begin to show hyperpnea at 104 degrees F., which becomes greater as the high temperature is prolonged. Occasionally one states that he feels nauseated or that his head aches. The systolic and diastolic blood pressure is decreased when high temperatures are produced. On the whole, patients do not appear to be greatly distressed or fatigued when the maximum temperature is maintained for one hour and then allowed to return to normal while the patient is well blanketed. We believe that the condition of our patients after treatment is much more satisfactory than that reported by investigators who have used other methods to produce artificial fevers.

We have also placed the plates above and below the body so that, as the patient lay on his back, the waves were oscillating from front to back and *vice versa,* but we were not successful because of peripheral burns from arcing. Various other methods to prevent heat loss from the body during the exposure, and to absorb the sweat, have been tried by us, but each has failed. Temperatures of 101 degrees F., and occasionally 102 degrees F., were attained, but as soon as there was excessive sweating, burning of the skin occurred, caused by the radio waves concentrating and arcing through a drop of sweat. The burns apparently were due to the heat from the arc as well as to the drops of sweat that were heated by the arcing.

Although it is possible to heat the body in the enclosed celotex box by the use of the short radio waves alone, time was saved by using the hot air blowers. The circulation of the hot air around the body prevented some heat loss because the air in the enclosed chamber rose from room temperature to 122 degrees F. in twenty minutes. The maximum temperature of the air in box at any time was 131 degrees F. The circulation of the air apparently keeps the humidity throughout the atmosphere in the chamber more uniform. Sweating occurred under these conditions, but the circulating hot air helped to prevent arcing and burning.

Although we are able to produce successfully artificial fevers with the radio waves as described, we realize that the equipment used and the method for applying this form of energy to heat the body can be greatly improved, and this is rapidly being done. Various theories explaining the rise of temperature of the body when exposed to short radio waves have been discussed by Carpenter and Boak[7] in another report. We believe that the development of heat is due to the resistance of the body to the conduction of current between the surfaces adjacent to the opposed plates. At each alternation of polarity of the plates the corresponding polarities are induced upon the adjacent boundaries of the interposed body and current is conducted through the material for a brief interval. The heating of solutions similar to the blood serum is dependent directly upon their electrical resistance. It has been shown that dilute solutions of different salts when of the same electrical resistance exhibit practically identical heating effects. In this report, however, we have concerned ourselves primarily with a method for raising the body temperature. Through the cooperation of Drs. D. Glen Smith and R. A. McTaggart, of Schenectady, New York, we have been able to study the effect of such heatings on patients suffering from various diseases. The use of therapeutic fevers is still in the experimental stage, but they have great possibilities if our conception of the significance of a febrile reaction is correct. We have studied the effect of fevers produced by short radio waves on various laboratory animals and on twenty-five patients, and thus far we have failed to observe any objectionable effect unless extremely high temperatures are maintained for long periods. We have proceeded, of course, with caution, and have followed closely the variations in body temperature, blood pressure, the pulse and respiration. The use of such a method demands conservatism and sound judgment because of the comparatively short time it has been studied. However, we are of the opinion that, because of the practicality of this method of heating, it may be of value not only to the clinician, but also to the physiologist, the biochemist and the bacteriologist.

Studies of infectious diseases in laboratory animals that will be reported elsewhere lead us to believe that two desirable effects are obtained by raising the body temperature. First, the increased heat within the body makes a less favorable environment for the multiplication of a virus. Second, the heat increases the rate of those chemical processes concerned with the development of immunity and with the general defense mechanism of the body against infectious agents.

We are grateful to Dr. W. R. Whitney, director of research of the General Electric Company, and to Mr. K. C. DeWalt for their constant help and suggestions, and for the apparatus used in this work. We thank the staff of the Ellis Hospital, Schenectady, New York, for their cooperation.

SCIENTIFIC EVENTS

THE ZOOLOGICAL SOCIETY OF LONDON

THE London *Times* reports that the one hundred and first annual report of the Zoological Society of London, issued to fellows in anticipation of the general meeting on April 29, contains an appendix describing the centenary celebrations held last year. The addresses of the president on the general history of the society, and of the secretary on the scientific history, and the speeches of congratulation delivered by the chief delegates of other societies are printed in full. A list of the delegates who attended the celebrations and accounts of the dinner, at which the Prince of Wales was the chief guest, of the garden party attended by over 8,000 fellows and their friends, and of the dinner to the staff are given.

The body of the report, as usual, describes the progress of the society. The total assets amounted to £171,571, an increase of nearly £30,000 on the preceding year, but the liabilities were increased by £44,673, due almost entirely to a bank loan to defray the cost of the new refreshment rooms. On account of the tenure of the gardens, the value of buildings erected by the society can not be included in the assets. The income was £7,000 and the expenditure £5,000 less than in 1928. Rent, rates, income-tax and insurance cost over £5,000, provisions for the animals £15,500, scientific work, including the library and the cost of publications, cost nearly £10,000. The admission fees and subscriptions of fellows amounted to over £24,000, the income from gate-money was nearly £66,000, from the aquarium over £16,000, and the refreshment-room profits were nearly £17,500.

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[7] Carpenter and Boak, to be published in *Am. J. of Syphilis.*

The pathologist reports that there was a notable decrease in the incidence of tuberculosis in mammals and birds since the construction of the new Monkey House and the Bird House. It is noted that, although special attention was given to cases of disease among parrots, there was no case of psittacosis during the year and no outbreak of epizootic disease in any of the aviaries. On the other hand, an acute and rapidly fatal outbreak of enteritis, peculiar to Felidae and known as "cat distemper," occurred during August and September.

Considering the limited accommodation, there was a good deal of breeding. Three lions, six wolves, five foxes, a baboon, a yak, an American bison, a mountain zebra, a Bactrian camel, a Mongolian wild horse, a kiang, five deer, five antelopes, seven mouflon, seven thar, five Barbary sheep, three ibex, a beaver, a fruit-bat, as well as many smaller mammals, were bred and reared. The experimental breeding of budgerigars was continued, and 229 were bred and reared, including 86 of the blue and nine of the cobalt varieties. A large number of pheasants and some wild turkeys and geese were bred on the society's estate at Whipsnade.

ASSIGNMENT OF PATENT RIGHTS TO THE ST. LOUIS UNIVERSITY SCHOOL OF MEDICINE

THE announcement by Dr. E. A. Doisy at the thirteenth annual Physiological Congress in August, 1929, of the isolation of a follicular hormone has given rise to so many personal problems for Dr. Doisy and so many administrative problems for St. Louis University that effective measures had to be devised for dealing with them. Quack remedies of various kinds have quoted their potencies in Allen-Doisy rat units and have used the discovery of the "sex remedy" in various entirely unjustifiable advertising appeals. In at least one case, the university was forced either to enter a disclaimer or to protect its good name by still more stringent measures. In the interest of public health, ethical advertising and recognized standards in pharmaceutical manufacture, the president of St. Louis University has created a committee to be known as the Committee on Grants for Research, composed of the dean of the School of Medicine, the associate dean and the professor of biochemistry, to deal with full power with the various questions arising out of the situation.

On February 7, Dr. Doisy and his coworkers, Clement D. Veler and Sidney A. Thayer, had assigned to St. Louis University any patent rights which may be thought wise to secure in order that the difficulties just enumerated might be properly met. The terms of the donation provide that the eventual income, if any, is to be used entirely for the prosecution of research in the School of Medicine; any funds accruing are to be administered as the other funds of the School of Medicine subject to the general financial policies of the university.

The president of the university, in accepting this donation, committed to the newly established Committee on Grants for Research the administration of all contractual or other relationships which may arise within the university or out of it from the newly isolated product. He further empowered the committee, subject to the general university administration, to allot its income in accordance with the wishes of the donors and to administer a testing laboratory for ensuring a uniform and a dependable product.

The Council on Chemistry and Pharmacy of the American Medical Association recognized Dr. Doisy's right to name the newly isolated compound and has approved of the name "Theelin" for this follicular hormone. The Committee on Grants for Research has completed arrangements with a reputable commercial house manufacturing biological products. By the terms of the agreement, provision is made that all developments in the preparation of "Theelin," its clinical applications and the discovery of its properties must be shared alike by the university, on the one hand, and the licensee or licensees under the patent rights, on the other. In effect, therefore, cooperative research by all those interested in the manufacture and sale of the product is assured.

The one manufacturing company which has thus far been licensed will enjoy the exclusive right in the United States for the manufacture and sale for eighteen months. After that period, however, the patent rights are not restricted and other firms may be given license to manufacture and distribute under the same restrictions under which the first licensee is operating. The fullest liberty of publication is assured by the terms of the agreement. Moreover, all licensees will be required to submit their products to the testing laboratory of the university. It is the intention of the university to publish the various documents in regard to these arrangements in a special bulletin.

THE PLACEMENT SERVICE OF THE FEDERATION OF AMERICAN SOCIETIES FOR EXPERIMENTAL BIOLOGY

SOME ten years ago the Federation of American Societies for Experimental Biology, comprising the American Physiological Society, the Biochemical Society, the Pharmacological Society and the Society of Experimental Pathology, established a Placement Service, the function of which was to act as a medium of communication between those seeking positions in the above named sciences and institutions having vacancies in these departments. Previous to the establishment of this "Service" it was exceedingly difficult, for the young men especially, to make a change in location. In the first place they were just beginning their training, had perhaps taken their doctor's degree, but naturally they were not likely to hear of vacancies in other institutions. On the side of the universities it may be said that they often had vacancies, but they had difficulty in getting in touch with those who might be considered for an appointment. It was to remedy this situation that the service was established about ten years ago. During these intervening years it has been functioning in a quiet way, but with the wider knowledge of its existence its activities have increased considerably during the past three or four years.

At the present time, in addition to those who have already been placed, there are enrolled this year the names of forty who are desirous of a change of location. It is interesting to note the distribution of these forty among the various preclinical sciences. There are registered

Physiologists	14
Biochemists	20
Pharmacologists	5
Pathologist	1

These figures represent what may be called a typical distribution of the total registration as it has appeared for the past few years. The number of institutions represented on the active list at the present time is twenty-six. Twelve of these are inquiring for physiologists and ten for pharmacologists. It will be seen from these figures that the service is apparently filling a real need. It would be desirable, however, if more institutions would avail themselves of its help. It does little good for individuals to report that they are eligible for positions if institutions will not also report their vacancies. The peg is of little value unless there is a hole to fit it into.

It should be understood that the help of the service is open to non-members of the federation as well as to members and that there is no fee whatsoever charged for any help it may render. The executive officer of the Placement Service is Dr. C. W. Edmunds, Department of Pharmacology, University of Michigan, Ann Arbor, Michigan.

RADIO TALKS

The National Broadcasting Company and the Press Service of the American Association are cooperating in a series of radio talks on scientific subjects which will be given over the National Broadcasting Company's network of stations covering the entire country.

These talks are offered under the auspices of a special board of sponsors, of which the membership is as follows: Dr. Robert A. Millikan, director of the Norman Bridge Laboratory, Pasadena, California, president of the association; Dr. Henry Fairfield Osborn, president of the American Museum of Natural History, New York; Professor J. McKeen Cattell, editor of Science and *The Scientific Monthly;* Dr. Leland O. Howard, principal entomologist, Bureau of Entomology, U. S. Department of Agriculture; Dr. John C. Merriam, president of the Carnegie Institution of Washington; Dr. Vernon Kellogg, secretary of the National Research Council, Washington, and Professor Harlow Shapley, director of the Harvard College Observatory.

These talks will be given by our leading scientific men and by visiting scientific men of international prominence. Each talk will be timely, and will include information of real news value. It is expected that many fundamental discoveries in all fields of science will first be announced to the public in this way.

Austin H. Clark,
Director, Press Service

THE JOSIAH MACY JUNIOR FOUNDATION

The Josiah Macy Junior Foundation for preventing and curing disease and relieving human suffering has been established through a gift of $50,000,000 by Mrs. Walter Graeme Ladd, of Far Hills, N. J. The foundation was incorporated on April 23 in Albany, with Dave Hennen Morris chairman of the board.

The foundation is a monument to the memory of Mrs. Ladd's father, who died in New York in 1876. He was president of the Devoe Manufacturing Company.

Dr. Ludwig Kast, since 1906 professor of clinical medicine at the New York Post-Graduate Medical School, has been elected president of the foundation. He reports that the trustees intend to start work immediately on an outline of their course of action.

It is understood that the foundation will not limit its work to any particular field, but that it will probably lean most strongly toward development of methods to relieve the suffering of the mentally disordered.

In the letter accompanying her gift Mrs. Ladd said in part:

> It is my desire that the foundation in the use of this gift should concentrate on a few problems rather than support many undertakings, and that it should primarily devote its interest to fundamental aspects of health, of sickness and of methods for the relief of suffering.
>
> To these ends the foundation might give preference in

the use of this fund to integrating functions in medical sciences and medical education, for which there seems to be particular need in our age of specialization and technical complexities.

At the first meeting of the directors, held on April 22, the officers were elected as follows: Josiah Noel Macy, secretary of the board, a nephew of Mrs. Ladd and son of the late V. Everit Macy; Valentine E. Macy, Jr., treasurer, brother of Josiah Noel Macy.

The executive committee consists of the president, the chairman of the board, Dr. James F. McKernon, the Rev. Samuel Trexler, Frederick J. Faulke. Marlborough Churchill, Lieutenant-Colonel U.S.A., retired, is executive secretary. The temporary offices are at 565 Park Avenue. Other members of the board are the Rev. Harry Emerson Fosdick, Chester H. Aldrich, J. Macy Willetts, Lawrence Morris, Professor John Dewey, Dr. Nellis B. Foster, Hamilton Hadley, Dr. Stewart Paton, of the Johns Hopkins University.

SCIENTIFIC NOTES AND NEWS

A MESSAGE has been received from Sir William Bragg, of the Royal Institution of London, accepting an invitation to attend the Ithaca meeting of the American Physical Society from June 19 to 21, and announcing the title of a paper for the meeting on "Faraday's Diary." The subject is a peculiarly appropriate one at this time, since Faraday's famous experimental researches in electricity, which formed the foundation upon which all modern electrical developments rest, were begun—at the Royal Institution—almost exactly one hundred years ago.

PROFESSOR G. H. PARKER, of Harvard University, is on his way to the University of Cambridge, England, where he will lecture during May. He will spend June and July visiting zoological laboratories in Europe and will return to America early in August.

AT the annual dinner of the National Institute of Social Sciences at the Hotel Roosevelt, New York City, on May 8, gold medals of the institute will be presented to Dr. George Richards Minot, professor of clinical medicine in the Harvard Medical School; to Anna Billings Gallup, curator-in-chief of the Children's Museum, Brooklyn, N. Y.; to William Lyon Phelps, professor of English language and literature, Yale University, and to Mr. Nathan Strauss, New York City. The presentations will be made by Dr. Michael I. Pupin, Dr. William B. Castle, Dr. C. Stuart Gager and Dr. Lee K. Frankel.

THE Faraday Medal was presented to Sir Ernest Rutherford at a meeting of the Institution of Electrical Engineers on May 1. The presentation preceded the twenty-first Kelvin lecture, delivered by Mr. R. H. Fowler, on "Some Recent Advances in the Electron Theory of Metals."

IT is announced in *Nature* that Dr. A. T. Doodson, associate director of the Liverpool Observatory and Tidal Institute, has been awarded a prize of £150 offered by the Royal Society of Arts in 1929, under the Thomas Gray Memorial Trust, for an improvement in the science or practice of navigation, for his work on the analysis and prediction of tidal currents.

THE annual dinner of the New York Alumni Association of the Johns Hopkins University was given on April 22 in New York City with Dr. Joseph S. Ames, president of the university, as the guest of honor.

DR. FREDERIC W. SIMONDS completed in February forty years of continuous service in the department of geology of the University of Texas, where he became associate professor in 1890.

THE honorary doctorate of science was conferred on April 17 at the annual class-day exercises of the Michigan College of Mining and Technology on Cornelius Francis Kelley, of New York City, president of the Anaconda Copper Mining Company; James MacNaughton, of Calumet, president and general manager of the Calumet & Hecla Consolidated Copper Company, a former member of the board of control of the Michigan College of Mining and Technology, and on William Kelly, of Iron Mountain, mining engineer, for many years chairman of the board.

ST. ANDREWS UNIVERSITY will, at the graduation ceremonial on June 27, confer the doctorate of laws on Dr. Owen Willans Richardson, Yarrow research professor of the Royal Society and professor of physics in the University of London.

THE doctorate of science will be conferred in June by the University of Durham on Dr. Frederick George Donnan, professor of inorganic and physical chemistry in King's College, London.

DR. KARL M. DALLENBACH, of Cornell University, has been appointed visiting professor in psychology at Columbia University for the year 1930–31.

THE following appointments have been announced at Iowa State College: J. W. Woodrow, professor of physics at Iowa State College, head of the department of physics; Frank C. Vilbrandt, professor of chemical engineering at the University of North Carolina, professor of chemical engineering; Pearl P. Sanson, of Yale University, associate professor of foods and nutrition, and William B. Sarles, of the University of Wisconsin, assistant professor of dairy industry.

Dr. C. C. Bunch, associate professor of research otology in the Johns Hopkins Medical School, was recently appointed professor and head of applied physics of otology in the Medical School of Washington University, St. Louis. The appointment becomes effective on July 1.

The following appointments in the department of zoology at the State University of Iowa have been made, effective on September 1. Dr. H. W. Beams, of the University of Virginia, assistant professor; Dr. H. Wright, of the University of Indiana, and Dr. G. Marsh, of the University of Texas, associates.

The council of the Geological Society of America has voted to hold the next annual meeting in Toronto, from December 29 to 31. The following preliminary announcement is made of nominations for officers for 1931: *President,* Alfred C. Lane; *Vice-presidents,* Thomas L. Walker; Henry B. Kummel; Edgar R. Cumings (from the Paleontological Society); Alexander H. Phillips (from the Mineralogical Society); *Secretary,* Charles P. Berkey; *Treasurer,* Edward B. Mathews; *Editor,* Joseph Stanley-Brown; *Councilors 1931–1933,* Sidney Powers, Donnel F. Hewett; *Representative to the National Research Council,* E. H. Sellards. The Paleontological Society and the Mineralogical Society of America will hold meetings at the same time.

Officers of the Michigan Academy of Science, Arts and Letters have been elected as follows: Dr. Eugene S. McCartney, editor of scholarly publications of the graduate school of the University of Michigan, *president;* Professor A. M. Chickering, of Albion College, *vice-president,* and Professor Leigh J. Young, *secretary.*

At the annual general meeting of the Physical Society, London, held on March 28, the following officers were elected for the year 1930–31: *President,* Professor A. S. Eddington; *Secretaries,* Dr. Ezer Griffiths and Dr. Allan Ferguson; *Foreign secretary,* Professor O. W. Richardson; *Treasurer,* Mr. R. S. Whipple; *Librarian,* Mr. J. H. Brinkworth.

The Ray Society, London, which met on March 21, elected the following officers: Professor W. C. M'Intosh was reelected *president,* Sir Sidney F. Harmer, *treasurer,* and Dr. W. T. Calman, *secretary.* Sir David Prain was elected a *vice-president* and Canon Bullock-Webster and Mr. C. H. Oakden new members of the council.

Mr. S. M. Kintner, director of the Westinghouse Research Laboratory, has been made assistant vice-president of the company.

Eugene C. Sullivan, president of the Corning Glass Works, New York, has asked to be relieved of the presidency after service in that capacity since July, 1928. Upon his resignation he was elected vice-chairman of the board and will continue to be actively concerned in the policy of the company, particularly in research work.

Dr. J. J. Durrett, who recently resigned his position as chief of drug control of the Food and Drug Administration of the U. S. Department of Agriculture, returned to his former position on April 23. Dr. Durrett resigned to become state health officer of Alabama, and it was announced that Dr. F. J. Cullen would succeed him. It was later learned that Dr. Durrett upon reaching Alabama found the situation there unsatisfactory and on the initiative of Dr. Cullen his former position was offered to him.

The Medical Fellowship Board of the National Research Council, of which Dr. G. Carl Huber, dean of the Graduate School, University of Michigan, is the chairman, met on March 29 and made the following appointments for the year 1930–1931: *Reappointments:* Eric G. Ball, Edwin Marshall Deery, Milton G Levy, Ava J. McAmis, Leone McGregor, Charles Midlo and Bruce Webster. *New appointments:* James Bordley, III, Alexander Brunschwig, Jay Congor Davis, Norman E. Freeman, Wendell D. Gingrich, Minnie B. K. Harris, Richard W. Jackson, Carl E. Johnson, William B. Kountz, Salvatore P. Lucia, Margaret E. MacKay, H. Houston Merritt, Luther W. Oehlbeck, Robert A. Phillips, Charles E. Snelling, Teunis Vergeer, Frank H. Wiley and Alexander Zeissig. The next meeting of the Medical Fellowship Board will be held on October 4, and applications to receive consideration at that time should be filed on or before August 15.

Drs. E. D. Merrill, A. B. Stout, J. H. Barnhart, H. A. Gleason, and B. O. Dodge have been delegated to represent The New York Botanical Garden at the Fifth International Botanical Congress, to be held in Cambridge, England, from August 16 to 23. Dr. Merrill is a vice-president of the congress and, with Director-Emeritus Britton, is also one of the vice-presidents of the section on taxonomy and nomenclature. Drs. Merrill, Stout, Gleason and Dodge will present papers. Dr. Barnhart is one of the four American representatives on the international *ad interim* committee on the nomenclature of plants.

DR. CHARLES H. HERTY delivered the annual lecture to the Sigma Xi Club of the University of Alabama on April 12, on "Chemistry and the South."

A THIRD meeting of the group of physics students from the colleges in the vicinity of Philadelphia was held in the hall of the Franklin Institute on April 14. The meeting was addressed by Mr. Morris E. Leeds, of Leeds and Northrup, who spoke on "Physics and the Making of Scientific Instruments," and by Professor Arthur H. Compton, of the University of Chicago, who spoke on "Physics and Research."

DR. LAFAYETTE B. MENDEL, Sterling professor of physiological chemistry in Yale University, gave an address on "Nutrition and Growth" at the annual conference of the American Society of Orthodontists in Nashville, Tennessee, on April 10. He also spoke to the students of the Vanderbilt University Medical School on the following day.

THE scientific symposium lectures, given each spring under the auspices of the Buffalo Society of Natural Sciences, Canisius College and the University of Buffalo, will be delivered on May 6, 7 and 8, by Dr. Charles E. St. John, of the staff of the Mount Wilson Observatory. The subjects of the lectures are: "Exploring the Sun's Atmosphere," "The Natural Constitution and Extent of the Universe" and "The Observational Status of the Einstein Theory."

THE fifteenth Guthrie Lecture of the Physical Society, London, was given at the Imperial College of Science, South Kensington, on April 11, by Professor P. Debye, of the University of Leipzig, who spoke on "The Scattering of X-rays in Gases in Relation to Molecular Structure."

DR. J. ARTHUR HARRIS, professor of botany and head of the department of botany in the University of Minnesota since 1924, and from 1907 to 1924 botanical investigator at the Station for Experimental Evolution of the Carnegie Institution of Washington, died on April 24. Dr. Harris was in his fiftieth year.

THE eighth International Congress of Photography will be held in 1931 in Dresden. It will convene on Tuesday, July 28, and adjourn the following Saturday, August 1.

THE seventh annual meeting of the Alabama Academy of Science was held at the Alabama Polytechnic Institute April 18 and 19, in the new Ross Chemical Laboratory.

THE joint meeting of the Eastern Section of the Seismological Society of America and the Section of Seismology of the American Geophysical Union will be held at the Bureau of Standards on May 5 and at Georgetown University on May 6.

THE University of Virginia announces the establishment of a summer biological station at Mountain Lake, Virginia. The station is on the shore of a natural lake which covers an area of approximately 250 acres, with an average depth of 60 feet. The lake is 4,000 feet above sea-level and is surrounded by mountains which rise several hundred feet high. The average temperature during the summer months is approximately 70°. In the first year seven different graduate courses will be given, three in botany and four in zoology. The first term is from June 23 to July 26, the second term from July 28 to August 29.

THE seventeenth field conference sponsored by the Oklahoma Geological Survey was conducted in Southwestern Kansas and Northwestern Oklahoma from April 10 to 13. The leaders were Chas. N. Gould, director of the survey, and H. L. Griley, a petroleum geologist. The problem was the study of the Permian red beds of that region. Visits were made to nine type localities of the Permian in Southwestern Kansas, first described by F. W. Cragin nearly forty years ago. These beds were traced southward for more than one hundred miles into Oklahoma, and studies were made of the changes in stratigraphy and lithology in that distance. The general conclusion arrived at in this area was that individual beds in the Permian are not continuous over wide areas, but that in almost all cases the beds are more or less lenticular. Eighty-two men were in the party. Discussions took place both in the field and at the night sessions.

THE *American Mathematical Monthly* reports that under the auspices of the Edinburgh Mathematical Society a Mathematical Colloquium will be held in St. Andrews, Scotland, from July 19 to 30. The following courses of lectures have been arranged: "Rational Curves and Surfaces," by H. F. Baker; "Arithmetical Properties of Curves and Surfaces," by H. W. Richmond; "The Wave Mechanics," by C. G. Darwin; "Elementary Mathematics from the Higher Standpoint," by H. W. Turnbull; "Recent Developments in Symmetric Functions, Determinants and Algebraic Equations," by A. C. Aitken; "Theory of Functions," probably by Professor G. H. Hardy; informal talks by Professor E. T. Whittaker and others with discussions on the lecture courses.

THE Royal Geographical Society will celebrate its centenary in October this year. According to *Nature* and the provisional program recently issued, the celebrations will begin on October 21, with the opening of the society's new lecture hall and other new buildings at Kensington Gore by the king or one of the royal princes appointed by him. Other events will include addresses on the history of the society, on the history of exploration during the last century and on certain other aspects of geography. There will be a reception on October 22 and a centenary dinner on October 23.

The London *Times* reports that on the eve of the departure of Professor Nicholas Roerich, the Russian painter and archeologist, for Central Asia it was announced that there had been founded a Himalayan Research Institute, or Roerich Museum, with headquarters in the Kulu Valley, Western Himalaya. The institute, which will cooperate with the American Archeological Institute, is an outgrowth of five years' work in Central Asia of the expedition led by Professor Roerich. Among its honorary advisers are Dr. Ralph V. D. Magoffin, president of the Archeological Institute, Mr. Roy Chapman Andrews, Professors R. A. Millikan, Albert A. Michelson and Alexander Klemin, Professor Jacques Bacot, of Paris, Sir Jagadis Bose, Dr. Sven Hedin, Professor Albert Einstein and Professor A. Geoffré de la Pradelle.

DISCUSSION

A PLEA FOR SANITY IN NOMENCLATURE

The botanists of six continents are again preparing for another spasmodic effort to settle for all time their troubles with nomenclature. Preliminary discussions have been held, recommendations of all sorts made, committees appointed, excitement raised until the safety-valve is about ready to function, and next August all will be settled.

But will it? If history repeats itself, the trouble will be just as great five years from now as at present. Several codes of nomenclature have already been devised, beginning, if I am not mistaken, with that of Paris, in 1867, and all of them have been intended to produce stability in nomenclature. Instead of stability, every code has caused the change of many names and has induced stability only for those species about which there was no question in the first place. Botanists were content for a century with the good old name *Sassafras officinale* for our well-known sassafras, but the American Code compelled changing it to *Sassafras Sassafras*, and the latest, or International Code, turns it again into *Sassafras variifolium*. The red oak was known universally for more than a century as *Quercus rubra;* now that name is applied to a different species of oak and we are asked to call the red oak *Quercus americana*. Is that stability? No, it is merely legalized confusion. When one reads now about *Quercus rubra* he has no idea except from the context whether the southern Spanish oak or the northern red oak is meant. Codes of nomenclature have simply failed to give stability, and there is no prospect that any future code will be more successful in its aim.

The leading feature of every code is and has been priority. The oldest name shall be used, and the code merely decides how priority shall be judged, interpreted and applied in any specific case. In the last analysis, however, an adherence to the oldest name is not necessarily what we want; stability is the one desideratum, whether the accepted name is old or relatively new. Priority has been adopted as a means toward stability, but it has not given us the desired result. Under a rule of priority not one well-known specific name is safe against the possible discovery of an older one, except the names in the first edition of the "Species Plantarum," and even there we may find that we have applied Linnaeus's names wrongly, as was the case with the red oak, and feel compelled to displace them.

A scientific name consists of two parts, neither of which alone is the name of the plant. Yet we are required by all contemporary codes to bring together isolated halves of names and to construct new combinations which are to be valid, even though long antedated by other perfectly good names. It is undoubtedly proper, in combining two genera for taxonomic (not nomenclatural) reasons to bring the specific name into the genus, on the principle that half a loaf is better than none, but the displacement of an established name for this reason is folly. "Hold fast that which is good," as the apostle said. Yet the botanists of the world enthusiastically discarded the old Kew rule of considering only specific names proposed within the genus, which would have done away with all nomenclatural transfers and double citations, just as they also refused to accept the so-called Berlin rule that names not used for fifty years should have no nomenclatural standing. There are two principles, either of which would have tended toward stability, which botanists rejected. It appears sometimes that botanists do not want stability!

One of the greatest sources of confusion in names is caused by segregation of genera. Separation of a genus into smaller genera implies, naturally, that the segregator knows just what a genus is. On the contrary, it proves that a genus is not a biological entity, but merely a group of species, and that the prevailing fashion tends toward smaller genera, just as the prevailing fashion in dress, at least until this year, tended toward smaller skirts. But think of the trouble caused to the users of botanical literature by the segregation of many well-known genera! It is hard enough for the taxonomist to keep even with the so-called progress, and it must be impossible for the forester, the horticulturist, the pathologist and others who use plant names instead of merely playing with them. If rules are to be adopted, and in this law-making age it seems impossible to avoid them, we should have a list, not merely of names to be conserved, but also of generic concepts to be conserved, so that such well-known economic genera as *Pinus*, for example, should not be segregated.

The Vienna Code has one good point (or bad point, if you prefer) of giving a long list of *genera conservanda*, names which shall be used in spite of the existence of other prior names for the same genera. That is a step forward toward stability, and the list should be greatly extended and an additional list of *species conservandae* added to it, but it has the weakness of not stating for what the names should be conserved. I know one such genus of six hundred species which must be so conserved; unfortunately the name rightly belongs to another genus of about forty species, so that the entire six hundred should, under the rules, get a new generic name. Don't be alarmed, brother botanist, I shall never make these six hundred new combinations, and I believe that any one who does should be shot without waiting for sunrise. In fact, I have suggested a standard species for this genus (privately, so that no name-maker's attention will be called to the wonderful possibility) which, if the principle of standard species is adopted, will conserve the name in its present usage.

All systems of rules call for priority in the choice of specific names, and if I find a long-forgotten or never-used name in some obscure book, I am supposed to drag it out, dust it off and introduce it to the long-suffering botanical public. If we are going to have rules, why not have also a list of conserved publications to serve as the sole basis of available names? The only real hardship entailed by such a system would be that some botanists would be barred from their favorite indoor sport.

Another interesting point is the use of Latin in describing species, as required by the International Code. Most botanists wish to publish their knowledge and make it available to the world at large and accordingly choose a language which will be intelligible to many readers. So the Czechs and Poles almost always publish articles of extranational importance in another language and the Russians generally add a résumé in French or German. There is a suspicion extant, however, that the taxonomists of one country, which shall be nameless here, wish a monopoly of the knowledge of their own flora, and will begin publication of new species in their own language unless deterred by rules. Maybe we had better insist, after all, on the use of Latin for specific diagnoses.

Laws are generally of no avail unless the law-making body has the power to enforce them. A weakness of all codes of nomenclature has been the lack of this power. As an example, nearly ten thousand new names have been published without Latin diagnoses since the promulgation of the Vienna Code. One eminent botanist once told me that he could enforce on the botanical public any code of names he wished, if he could publish a better flora than any other then available.

All these points go to show the weakness of nomenclatural rules in securing stability of names. Why then have any rules at all? Instead of a complicated code, always subject to change, always subject to disregard in one or more provisions by some botanists, always subject to differences of interpretation, let each botanist adopt the following principles (not rules) for his own work and follow them conscientiously, and stability of nomenclature will be as nearly assured as it ever can be: first, I shall not reintroduce, or insist on the use of, forgotten or nearly forgotten names; and second, I shall not change the scope of any group of plants unless I firmly believe that I am actually adding to our knowledge of plants thereby.

H. A. GLEASON

NEW YORK BOTANICAL GARDEN

TEST OF THE WEGENER HYPOTHESIS BY MEANS OF GEODETIC DATA IN INDIA

IN Vol. III of the Geodetic Report of the Survey of India for 1927 (published in 1929), are data which are of interest in connection with the Wegener hypothesis. Under the heading "International Longitude Project" is given a somewhat detailed account of the work done at Dehra Dun in 1926 in connection with the world longitude campaign. The statement is made that "the mean of these gives the final value of the arc Dehra Dun—Greenwich to be $5^h\ 12^m\ 11.^s794$. . . . The above figure may be compared with the old value of $5^h\ 12^m\ 11.^s770$, derived from the Indo-European telegraphic arc of 1894–96."

Under the heading "Computations and Publication of Data" is a statement regarding the variation of latitude which reads as follows:

> As a result of an enquiry from Professor Wegener, the values of astronomical latitudes, found at stations in India at which observations had been taken at more than one time, separated by considerable periods, were scrutinized to see whether they afforded any evidence of earth movement. The results are given in Table 2. They have not been cleared of polar variation.

A table showing the variation of latitude at a number of old stations is then given, after which occurs the following statement:

> Five sets of observations, at Mussoorie, Sangatpur, Harnāsa and Kundgol, cover intervals of less than a year each, in spite of which they show changes not much smaller than those of the others. Of the remaining stations, four out of five show increases in latitude between

1800 and 1870, and three out of six show increases between 1870 and 1927. The changes at Gogīpatri and Poshkar, which are situated 15 miles apart, are directly contradictory. It can only be concluded that all the changes may be attributed to errors of observation or of star place, and that there is no evidence of continental drift. Nor, on the other hand, is there any disproof of the existence of a drift of the order of fifty feet per century.

The latitude and longitude data for India indicate very clearly that there is no rapid movement of that country in a north and south or an east and west direction. There is no possible way to tell whether or not there is a very slow drift. It will take another century or more, with repeated astronomical determinations of latitude and longitude, to get any clear idea as to the stability or instability of the Indian region. It is interesting, however, to have the valuable evidence contained in the report from India.

William Bowie
U. S. Coast and Geodetic Survey

ANTAGONISM BETWEEN ZOOPHARMACOLOGY AND PHYTOPHARMACOLOGY

Dr. David I. Macht has presented an interesting review of cases of the dissimilarity between the zootoxic and the phytotoxic action of various alkaloids and toxins.[1] To quote from his article:

> It has been the experience . . . that poisons produced by plants, or phytogenic poisons, are more toxic for animals than for plants, while poisons elaborated or produced by animals, or zoogenic poisons, are commonly much more toxic for living plant protoplasm than for living animal tissues.

It would be possible to extend this idea of an antagonism between animals and plants to the subject of diseases and their treatment. If we consider the bacterial diseases of animals as diseases in which a plant (the bacterium) is infecting an animal host, we find that these diseases are, as a general rule, virulent. The infecting organism does not show any compatibility with the host, and produces various highly toxic substances (the bacterial toxins) which circulate in the blood stream and very rapidly bring the disease to a crisis from which the animal either dies or recovers. In the case of recovery, we find a very marked protective reaction on the part of the animal host, as indicated by the production of various immunological substances, the antitoxins, bacteriolysins, agglutinins, opsonins, etc. The net result is either that the plant (bacterium) kills the animal, or that the animal kills the plant. We have, therefore, in this case, no compatibility between the two forms, but instead a marked incompatibility.

When we consider the infestations of an animal host with animal parasites, we have a markedly different picture. The host and parasite live together without any marked protective or offensive action on the part of either. When death occurs in these conditions, it is a result of the gradual destructive action of the parasite on some particular tissue of the host. The tapeworm, the liver fluke, the malarial plasmodium, the trypanosome, the filaria worm, the spirochete and the intestinal ameba may be taken as examples of this type of infesting organism. These organisms do not produce any great amount of toxins, and do not stimulate the host to form any great amount of protective substance. The host and parasite are seemingly quite compatible, and live together in what might be called a semi-symbiotic relationship, until gradually the infesting organism produces enough organic damage to the host to interfere with normal function. These diseases are, therefore, of a chronic type as compared with the virulence of the bacterial diseases.

This antagonism between animals and plants is reflected in the treatment of our diseases. If we wish to cure a bacterial disease we either let the patient prepare his own defensive substances (let the patient get well), or we make use of the same defensive substances prepared by another host (the antitoxins). Ordinarily, treatment and medication are valuable only in so far as they make for the physical welfare of the patient. If we wish to cure our infestations with an animal parasite, we must make use of various plant extracts (quinine and emetine are examples), or resort to the preparation of synthetic chemotherapeutic agents. The patient is practically entirely powerless to cure the disease completely, although he may reach an equilibrium with the parasite, in which the disease is to all intents latent, but from which condition the disease may later flare up and the patient suffer a relapse.

We may, therefore, entrust the treatment of bacterial infections to the patient, the physician or the bacteriologist and immunologist, knowing that their efforts will be assisted by the natural antagonism between the host and the infecting organism. In the parasitic infestations, the host, the physician and the parasitologist can do no more than describe the disease. The cure of the disease must be sought for in the growing field of chemotherapy.

Edwin H. Shaw, Jr.
Biochemistry Laboratory,
University of South Dakota

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[1] Science, 71: 302–306, March 21, 1930.

TEREDOLITHUS, A NEW COLLECTIVE GROUP NAME

Quite a number of fossil ship worms have been described under the generic name Teredo. Most of these names were based upon fossil woodborings or the lining of burrows and occasionally upon shells. These parts without the pallets unfortunately do not furnish characters which are at present considered of prime importance in ship worm classification.

Recent studies of the living species have demonstrated that ship worms, like other bivalve mollusks, have restricted ranges, and this knowledge will undoubtedly be used by paleontologists in dealing with fossil species, which will result in the description of many new forms in the future.

Since the classification of recent species is now quite well established it seems a pity to burden the rather limited group Teredo with the many specific means which no one can at present place in their proper genus. It is for that reason that I now suggest the collective name Teredolithus for the reception of these generically indeterminate species of ship worms. This name is not to be considered a genus in the accepted sense, but a convenient repository for such species as we find at present generically indeterminable. This name is to have no type, and therefore continue in use as long as generically indeterminate ship worm species exist.

The splendid precedent for a somewhat similar procedure was established by Dr. Stiles in 1907, when he created the name Agamofilaria for the reception of species of Filarids based upon larval forms which failed to furnish the characters for proper generic designation. This group name has served and is still serving a useful purpose as a more or less temporary resting-place for immature Filarids.

Some of the American fossil ship worms which should be placed under Teredolithus are: *Teredo calamus* H. C. Lea, *T. circula* Aldrich, *T. dendrotestes* Brown and Pilsbry, *T. emacerata* Whitfield, *T. fistula* H. C. Lea, *Kuphus incrassata* Gabb, *Teredo mississippiensis* Conrad, *T. pugetensis* White, *T. simplex* Lea, *T. substriata* Conrad, *T. tournali* Leym. and *T. virginiana* Clark.

PAUL BARTSCH

U. S. NATIONAL MUSEUM

DISCOVERY OF PHOSPHORUS FIXING COMPOUND IN THE SOIL

THE Louisiana Experiment Station has found an iron compound in southern soils which is responsible for the fixation of phosphorus. In the poorly drained soils the compound exists as concretions, ranging in size from below the visibility of the naked eye to fine gravel. In the well-drained soils, the concretions are not so much in evidence.

The concretions usually consist of a series of smaller ones. They are black in color, and when wet are rather soft. The structure is very open, and when the concretions are placed in water they emit a singing noise due to escaping air.

The physical structure of the concretionary material is such that it forms a very reactive compound. It appears that the phosphorus in this compound occurs as a basic ferrous phosphate. Drainage apparently determines whether the basic ferric or basic ferrous phosphate occurs.

The solubility of this phosphorus compound is exceedingly low, about .2 ppm. PO_4 in a .002 N. H_2SO_4 acid solution. As the amount of PO_4 varies in this basic compound it is likely that the solubility also varies. The effect of saturating this compound with PO_4 on the solubility is being studied, as well as various other soil treatments.

A. H. MEYER

LOUISIANA STATE UNIVERSITY

THE BANANA IN EARLY BOOKS: FRUIT OR STEM?

IN a paper[1] published recently I made the statement that the banana, as known to-day, existed in India before the Christian era, but further examination of the evidence makes me less sure of that conclusion. The earliest record, Megasthenes (303 B. C.), refers to a banana, but speaks only of the pseudostem as being eaten. The frescoes of Ajantâ (400 B. C. to A. D. 700) show unmistakable banana plants, but a careful examination has failed to discover any pictures of the fruit, although the mango, lime, custard apple, aubergine and other fruits are clearly illustrated. It seems probable, therefore, that the stem and not the fruit of this banana was eaten. I had previously accepted Pliny's interpretation of Theophrastus' statements as probably referring to leaf, flower and fruit of a single plant but am now inclined to take a more literal translation. In that case only the second "Ετερον δέ οὐφὺλλον . . . ," that referring to the leaf, can positively be connected with the banana. Ibu Serabi says, "Musa. Abēmesuai ē calu ē medio primi grad' humidū ī fine eius nutrit par," and Ibu Sina, though using the name Musa, does not say whether the fruit or stem was eaten. It is not until 1563, with Garcia da Orta, of Goa, that I find the fruit of the banana definitely referred to as being eaten. I can not accept Rung's[2] evidence of its existence in pre-Christian Egypt as convincing, for his figures may represent hands of bananas but look at least as much like bundles of faggots tied together. The evidence of its existence in America is even less convincing. It seems evident that the Physocaulid bananas, *Musa Eusete*, *M. glauca*, etc., were known in North Africa, Asia Minor, India and perhaps America at a very early period but that the Eumusae were unknown in these regions until a much later date than we had supposed. I should appreciate any references that I have missed and especially any pre-Christian records from the Malay Peninsula, Siam, Cochin China or the East Indies.

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[1] Philip R. White, "Studies on the Banana," *Zeitschrift f. Zellforsch. u. mik. Anat.*, 7: 678–783, 1928.

[2] Richard Rung, "Die Bananankultur," in J. Perthe's "Geog. Anstalt," Bonn, 1911.

Philip R. White

Boyce Thompson Institute
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THE COLOR-BLINDNESS OF INDIANS

The department of psychology of the University of Denver has begun a preliminary study of color-blindness of Indians. In the spring of last year (1929) we tested 390 Indians of the southwest with the Ishihara test for color-blindness, and found seven red-green blind, but none definitely totally color-blind. This is an incidence of not more than 2 per cent. Only one was a female. It is planned to visit numerous Indians of the central far west and administer the same test with the Nela test from the Johns Hopkins University during the spring and fall of this year so as to determine if the incidence of color-blindness among Indians is greater or less than it is among whites.

T. R. Garth

University of Denver

THE PRESIDENCY OF THE BRITISH ASSOCIATION

In the extract on the British Association from the London *Times*, reprinted in Science of April 4 (p. 354), it is stated "if General Smuts becomes president of the London meeting (in 1931) he will be the first president elected from one of the Dominions." It may be noted Sir William Dawson, of Montreal, was president at the 1886 meeting held at Birmingham.

A. F. Hunter

Toronto

SCIENTIFIC BOOKS

Methodik der wissenschaftlichen Biologie. Edited by Tibor Peterfi. Vol. 1, Allgemeine Morphologie, xiv + 1425 pp., 1 col. pl., 493 figs. in text. Vol. 2, Allgemeine Physiologie, x + 1219 pp., 358 figs. in text. Berlin, Verlag von Julius Springer. 1928. Price (bound), 198 marks.

A particularly illuminating insight into the rate of progress in the biological sciences, a layout of their diversification and ramifications and a display of the dominant directions of biological developments can be observed in a comparison of the contents of Peterfi's recent monographic encyclopedia of methods of scientific biology with any book in the fields of methods, say of fifty years ago. The very word biology in the last half century has itself acquired new and wider meanings and has established itself beyond displacement by the quibbles of botanists and zoologists, followers of disciplines diverted from their common interests by the artificial jurisdictions of herbarium and museum. There is really only one biological science, though many avenues approach it. Both the diversity and divergences of these avenues as well as the unity of the science of biology are revealed in this encyclopedia of biological methods.

As an index of the shift in emphasis and selection in biological work now current, possibly somewhat distorted by editorial guidance, one notes that the entire subjects of botanical and zoological collecting and of museum and herbarium technique are restricted to 148 pages of the total of 2,644, which is less than the space devoted to the care of living plants and animals. There is less occasion for the inclusion of these subjects under "Allgemeine Physiologie."

No one person could possibly function as an expert, and scarcely even as a critical compiler of methods in so diversified a field. Hence Dr. Peterfi has associated with himself in this enterprise no less than forty-two other biological specialists, each of whom is responsible for one or more chapters in this work.

The first volume deals with general morphology, but in a more restricted sense than the extremely comprehensive "Handbuch" of Aberhalden which covers the entire field of the natural sciences. The aim has been rather to restrict the subject to, and to intensify the treatment of, those fields of the natural sciences which are more or less distinctly morphological or which impinge thereon. The first volume is therefore written for morphologists, botanical and zoological alike. It includes the basic methods of morphology, microscopy, the study of cells, tissues and of development.

The volume opens with a 200-page introduction to the mathematical treatment of biological problems by Professor A. Walther, with abundant illustrations of the applications of formulas and graphs to specific biological data. Professor A. Köhler discusses the optics of the microscope and Dr. H. Zocher the ultramicroscope.

The subject of general microtechnique is introduced by Fr. P. Vonwiller with articles on the use of direct illumination and on vital staining, by Dr. R. Keller on electrohistological staining reactions and by Professor G. Levi on tissue culture, while Professor T. Peterfi writes of micrurgie, or the study of cells with the micromanipulator; Professor G. C. Heringa writes on the making of permanent microscopical preparations, and Dr. K. Belar on descriptive cytology.

The field of special microtechnique is somewhat unevenly broken up and developed under the headings of Protozoa by Dr. K. Belar, vital staining in plants by Professor E. Küster, permanent botanical preparations by Dr. H. Schneider, animal tissues and histochemical methods by Professor B. Romeis, cell pigments and lipoids by Dr. M. Schmidtmann and general and special methods in histochemistry by Professor G. Klein.

Methods in descriptive embryology, including collection, fixation, preservation and sectioning of embryos and the demonstration cavities and of vessels by injection and corrosion methods, are described by Professor E. Pernkopf. There is no treatment of the preparation of models from sections.

The final section deals with microscopical methods as applied to the skin, nervous system and sense organs of invertebrates and to several of the principal invertebrate phyla by Dr. J. v. Gelei.

The outstanding chapters in this comprehensive volume are those of Dr. Köhler on the theory and construction of the optical parts of the microscope, Dr. Peterfi's account of microdissection apparatus and Dr. Belar's discussion of the technique of cytology.

The second volume is assigned by title to "Allgemeine Physiologie." Possibly, since systematics are at present under the tabu of orthodox biology, the editor has conceded a place in the kindly shade of physiology [*sensu latu!*] to "Zoologische Musealtechnik" by Professor C. Zimmer and to "Botanische Museumskunde" by Professor J. Schiller, with "Herbarpflanzen" by Konservator Dörfler slipped in as an "Anhang," while the article by Professor P. Schulze on the collection of zoological material for investigation is permitted to devote all of two pages to vertebrates.

Continuing in the field of physiology, we find sections devoted to the maintenance and rearing of animals and plants, with chapters on fresh-water aquaria and terraria by Professor L. Müller, on sea-water aquaria by W. B. Sachs, on insects and insectaries by Professor A. Hase and on mammals by Professor H. Nachtsheim, while Professor E. Küster and Professor F. Oehlkers treat respectively the lower and higher plants.

The following section treats of photography, microphotography, cinematography, microcinematography and the technique of drawing. The last named, by Dr. K. Belar, is very helpful, though he omits mention of the exceedingly useful Wolff carbon pencils.

Methods in the study of heredity by Professor G. Just include the mathematical treatment of variation, a brief discussion of the analysis of individual characters and a very full account of methods in genetics in *Drosophila* and in man.

Developmental mechanics in plants is treated by Dr. A. T. Czaja and in animals by Dr. O. Mangold, including a most welcome account of the methods used in the study of external and internal factors, such as gradients, isolations, defects, combinations and transplantations, to which appendices on artificial parthenogenesis and cell stimulation are added.

A nearer approach to physiology is attained in the chapter on methods in aseptic operation by Professor H. F. O. Haberland, in the physiology of stimulation by Professor O. Koehler and of protoplasm by Professor J. Spek, on plant physiology by Professor E. G. Pringsheim, on electrometry by Dr. G. Ettisch, on the metabolism of cells and tissues by Dr. H. A. Krebs, on metabolism in plants by Dr. O. Arnbeck and on substance and energy changes in plants by Dr. J. Hirsch.

In face of the difficulties which arise from the dimensions of the fields covered, the inevitable omissions of desirable portions of the many fields and the obvious inequalities in the treatment of different subjects, the editor has succeeded admirably in producing a most useful encyclopedia of modern biological methods which every biologist will find exceedingly useful as a work of reference for methods in a wide range of biological investigations.

The current methods in German laboratories are to be found here with a moderate but by no means adequate account of those from other sources. There is a glossary of equivalent technical terms in German, English, French and Italian. The different subjects are extensively documented, but citations are largely drawn from German sources; for example, the closing chapter cites exclusively from such sources.

In these days of increasing specialization and of new developments a synthetic work such as this is both an aid to progress and a stimulus and a guide to endeavor.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN ELECTROMAGNETIC PUMP

DURING the course of some investigations in this laboratory, it became necessary to devise a pump which could be used to circulate sterile fluid in a system free from any rubber, metal, oil, grease or cement. To fulfil these requirements, a pump has been constructed entirely of glass, in which the motion of the piston is actuated by electromagnetic forces.

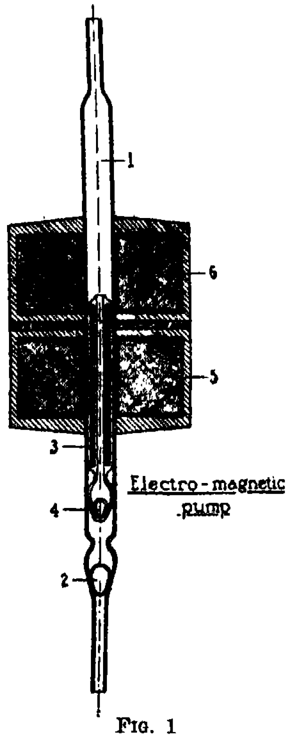

Fig. 1

The diagram shows the pump in cross section. The pump cylinder (1) is a glass tube which has a carefully ground valve (2) at its lower end. The piston (3) consists of two tubes with a soft iron core fused between them. The lower end of the piston has a valve (4) which is identically the same as the cylinder valve (2). Both valves close by gravity. The pump cylinder is surrounded by a lower solenoid (5) and an upper solenoid (6). Both solenoids are hooked up in separate circuits. By means of a three-pole, automatic, mercury switch actuated by a rocking device, the electric current flows through the solenoids periodically in such a way that they are switched on and off, one after the other, with an intermediate state in which both solenoids are magnetized for a short time. Thus, a magnetic field is created inside the solenoids. The center of this field travels up and down periodically.

The iron core inside of the piston is attracted into the center of the magnetic field. The piston moves up and down continually, like the plunger of any pump. The up-stroke of the piston opens the cylinder valve (2) and closes the piston valve (4), while the down-stroke closes the cylinder valve and opens the piston valve. By this means, any fluid can be circulated or transferred.

The pump has many practical applications, especially where it is necessary to maintain sterility. It can also be employed for blood, and for strong acids, alkalis or other dangerous fluids.

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A METHOD OF SECURING MARINE INVERTEBRATES

When instructor in charge of Bryozoa in the course in marine invertebrates at the Marine Biological Laboratory at Woods Hole, Massachusetts, in 1918, Dr. C. L. Parmenter introduced the expedient of suspending microscope slides in racks from floats so as to be held below tide level and clear of the bottom near shore in the Eel Pond and outside in the harbor at the docks of the laboratory to become inoculated with Bryozoa colonies.

This method of securing young colonies of encrusting and stolonate Bryozoa, otherwise very difficult to study undisturbed or even to secure in any other way, has been continued and modified as occasion demanded by his successors in charge of this group. The writer, who is the present incumbent, learned of it from Professor D. B. Young when first succeeding to the group in 1926. During the past three summers the method has been used in securing young clean tunicate colonies and some solitary tunicates for class study. In addition young and very transparent Anomia individuals of varying sizes have been obtained in such condition that the heart-beat and other rhythmical activities may be very accurately observed and timed. Some study has been begun on the relation of these rhythms to varying temperatures and oxygen content of the sea water in finger-bowls in the laboratory. Some investigations have also been made on the early development of some of the encrusting Bryozoa so obtained. The transparent substratum is ideal for such studies. Material for class studies so obtained is more than satisfactory, but the uncertainty as to just what will turn up on the slides on a given day for study prevents its exclusive use as the basis for study of definite forms.

Among the animal species so obtained at different times and in some abundance were the following: Barentsia sp., Bowerbankia sp., *Bugula flabellata, B. turrita,* Schizoporella sp., Lepralia sp., Membranipora sp., Folliculina, Botryllus, Ciona, Hydroids, Microciona, Halicondria, Balanus sp. and Corophium, on the slides; and *Asterias forbesi* and *Arbacia punctulata* between them and inside the racks.

The following description applies to the racks now used and their methods of suspension.

Two pieces of wood 34.5 cm × 2.7 cm × 1.5 cm and two pieces 7 cm × 2.7 cm × 1.5 cm are fastened together to make a rectangular frame of 34.5 × 10 × 2.7 cm external and 31.5 × 7 × 2.7 cm internal dimensions. In the long sides of the rectangle so formed, in the interior face of each, and directly opposite each other, twenty saw-cuts are made to receive the glass microscope slides of ordinary size (3″ × 1″). The two open faces of the racks are then covered with zinc wire screen of about 0.8 cm mesh fastened along both sides of one and one side of the other by staples which, in the latter case, act as hinges and enable the rack to be opened for insertion and removal of the glass slides. These slides are inserted in the racks while clean, and the racks are then strung in pairs about three feet apart on tarred fish-net cord and a brick or stone sinker attached about five feet from one rack of the pair. The cord is so wound around the racks as to keep them closed, when suspended, and retain the slides in place. These are then suspended one above the other from the under-side of the floats, used as docks for small boats, in such a manner that the lower rack of each pair does not touch bottom even at low tide.

Somewhat similar methods have recently been reported as used for obtaining preparations of Protozoa and Algae by Butcher,[1] Lloyd[2] and Nauman[3] in Europe, and the method appears to be of wide applicability.

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SPECIAL ARTICLES

DETERMINATION OF POLYMERIZATION OF SOME POLYMER FORMALDEHYDES BY X-RAY METHODS[1]

In attempts to determine the molecular size of highly polymerized bodies (mostly assumed to be in the form of very long chains) by X-ray methods, only relatively small unit cells could be found. However, it was pointed out that this would not necessarily justify the assumption that the molecules were small, since a periodicity in a very long chain or the presence of molecules of varying chain length in one crystal could give similar experimental results. Thus, the controversy in regard to the constitution of polymers could not be settled in a definite fashion by X-ray analysis.

The experiences made in the study of polymerized formaldehyde (polyoxymethylenes) were of similar nature. Staudinger, Mie and Hengstenberg[2] and Hengstenberg[3] came to the conclusion that the molecular size of polyoxymethylenes could not be determined from X-ray methods. The absence of "inner" lines in the Debye-Scherrer diagrams made them assume that the structure could be represented as a lattice built up of CH_2O-groups exclusively and in a chain-like fashion. The residual groups which can be present and terminate the individual molecules are distributed at random throughout the crystal (different chain lengths) and do not cause any X-ray effects. If no residual groups are present the chain is extended throughout the crystal length. It must be emphasized, however, that no real proof for the existence of such chains is available from the X-ray standpoint. This interpretation of the X-ray results represents merely an adaptation to Staudinger's chemical conclusion.

Contrary to these results the author found the presence of "inner" lines.[4] In the first experiments only one such line was observed, which when considered as first order gave a degree of polymerization of 4.

The repetition of the experiments some months ago proved beyond doubt the presence of "inner" lines, only fortunately enough several orders could be observed, giving thus a means to determine for the first time the true length of the molecules of a highly polymerized body.

The preliminary results obtained are as follows:

δ-Polyoxymethylene: The following orders of the basis were measured: fourth, fifth, sixth, seventh, eighth, ninth, twenty-fourth and forty-eighth. The structure is closely hexagonal, the c-axes or length of the molecule is 45.1 Å.U. Neglecting the residual groups, the number of formaldehyde groups in the chain becomes 24 as calculated from the density. The length of one CH_2O-group then becomes 1.88 Å.U., which is in perfect agreement with the approximate value of 1.9 Å.U. of Hengstenberg which was determined from a series of acetyl derivatives of polymer formaldehyde. As to be expected, the twenty-fourth and forty-eighth orders have considerable intensities.

γ-Polyoxymethylene, sublimed: The eleventh, thirteenth, fifteenth, seventeenth and sixtieth orders were measured. The structure is more distinctly pseudo-hexagonal only. The length of the molecule is 113.4 Å.U. There are 60 CH_2O-groups in the chain (again neglecting the residual groups). The length of one formaldehyde residue is 1.89 Å.U., which again is a perfect agreement. The sixtieth order has the expected strong intensity.

Paraformaldehyde (Eastman Kodak organic chemicals): The sixth, seventh, eighth, ninth and thirty-second orders are measured. Again the structure is pseudohexagonal only. The molecular length is 60.6 Å.U., containing 32 CH_2O-groups. The CH_2O-group again possesses the length of 1.89 Å.U. The thirty-second order is intense. The three X-ray patterns show also distinct differences in regard to the "outer" lines.

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[1] R. W. Butcher, *Nature*, 125 (3147): 276, 1930.

[2] Ll. Lloyd, *Nature*, 125 (3142): 91, 1930.

[3] Nauman, *Ber. Deutsch. Bot. Ges.*, 37: 76–78, 1919.

[1] Contribution from the Department of Chemistry of the Johns Hopkins University; preliminary report.

[2] *Z. f. phys. Chem.*, 126: 425, 1927.

[3] *Ann. d. Physik* (4), 84: 245, 1927.

[4] Emil Ott, *Helv.*, 11: 300, 1928; compare also G. Mie and J. Hengstenberg, *Helv.*, 11: 1047, 1928; Emil Ott, *Helv.*, 12: 330, 1929.

The δ-product was examined with Fe-radiation, for γ- and para-formaldehyde Cr-radiation was used. Additional orders are indicated in all cases. α-Polyoxymethylene and ordinary γ-polyoxymethylene also show a series of "inner" rings, which, however, could not be measured thus far. These lines are more diffuse, indicating a less uniform composition of the products. Additional investigations are under way. A full account will be published shortly.

These results give a definite proof for Staudinger's view of the constitution of polymer formaldehyde. It is proved that in highly polymerized bodies molecules of identical length may crystallize together. The molecule of such polymerized bodies may be determined by X-ray research, which is highly important since no other physical methods give such definite results.

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TURNING OF THE SPERM IN THE ACRIDIAN FOLLICLE

In describing the spermiogenesis of a gryllid,[1] the author found in one species of cricket, *Nemobius fasciatus*, that first the nucleus and later the head are turned while elongating toward the open end of the follicles. The other species of crickets turn the head first toward the blind end of the follicle. Later these sperm turn in the follicle and enter the vasa efferentia, swimming with the head first. This phenomenon had not previously been described.

An examination of the literature revealed the fact that practically all the illustrations show the sperm forming with the head end toward the blind end of the follicle. This was particularly evident among the Acrididae, in which so many studies of spermatogenesis have been made.[2] The author therefore expressed the surmise that the sperm of grasshoppers turn in the follicle after they are formed.

This surmise he has confirmed by the study of many slides of fixed material. As the spermatids begin to elongate in the cysts all the nuclei move to the outer wall. In this stage the spermatids radiate out from the center. Later, as elongation continues, some of the heads move so that all point toward the blind end of the follicle. The elongation now continues until the head, and especially the tail, are very long. It is hardly thinkable that sperm could move any great distance with long flagella-like tails leading the way, and so the surmise was made that they turn in the follicle before leaving it. The following observations are believed to give evidence for this suggestion.

(1) In several specimens such elongated cysts contain clusters of heads which are still oval in shape. These are turned toward the blind end. Further toward the open end in the same cysts in a row beside the cyst wall are several heads all turned toward the open end. These were interpreted as having turned and being on the way to the open end of the cyst.

(2) In some very long follicles groups of heads lying around the periphery near the open end are headed in that direction. These are the sperm of a cyst which have completed the turning. In many cases these sperm are beside or in among degenerating cells—larger or smaller masses of mostly uniformly staining protoplasm. I suspect that these have to do with the nourishment of the sperm. The origin of these cells was not determined.

(3) Many of the much elongated cysts show, somewhere between the forming sperm and the open end, many tails which are plainly "looped." Sometimes these loops lie in the section. Others are cut in the curve part. In a few cases the heads are in this looped condition. Here is the point at which the turning or reversing is taking place. The number of tails (or heads) in the loops varies greatly in different specimens.

Some of the unturned heads have reached the elongated thread stage. Other sperm seem to turn while the head is still oval.

The details of the time, place and manner of the turning and relative phenomena are being investigated and will be reported on later.

W. J. Baumgartner

University of Kansas

BOOKS RECEIVED

Appleton, A. B. *Laboratory Guide to Vertebrate Dissection for Students of Anatomy.* Pp. xix + 152. Cambridge University Press. 6s. net.

Jennings, H. S. *The Biological Basis of Human Nature.* Pp. xviii + 384. 51 figures. Norton. $4.00.

Jordan, David Starr, Barton Evermann and Howard W. Clark. *Check List of the Fishes and Fishlike Vertebrates of North and Middle America North of the Northern Boundary of Venezuela and Colombia.* Pp. iv + 670. U. S. Department of Commerce, Bureau of Fisheries. Report of the Commissioner for 1928, with Appendixes. Part II. U. S. Government Printing Office.

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[1] W. J. Baumgartner, *Zeit. f. Zellforsch. u. micr. Anat.*, Bd. 9: 41, 1929.

[2] H. S. Davis, *Bull. Mus. Comp. Zool. Harvard Coll.*, 53: 59, 1908.

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THE APPLICATION OF ENGINEERING TO THE AGRICULTURAL INDUSTRY[1]

By HENRY GIESE

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IN a recent discussion of trends in business, Merle Thorpe, editor of *Nation's Business,* said that the first quarter of the twentieth century would probably be known as the age of mass production.

With the great industrial developments so immediately before our eyes it seems unnecessary to make further mention of them here. Rather it is our intention to speak regarding the progress which has been made in the agricultural field and the obligation of the engineer in helping it to keep pace with other enterprises. William M. Jardine, former secretary of agriculture, once said, "Could the farmer of the Pharaohs' time have been suddenly reincarnated and set down in our grandfather's wheat-field, he could have picked up the grain cradle and gone to work with a familiar tool at a perfectly familiar job." Imagine the amazement of the ancient Egyptian if he were to be set down in a present-day wheat-field with the combined harvester-thresher in full operation.

Less than a century ago more than 90 per cent. of our total population were directly dependent upon agriculture for a livelihood. In 1928, with fewer than 24 per cent. directly dependent upon the industry, our nation produced a surplus of agricultural commodities. American agriculture may be said to have had three power epochs: (1) human, (2) animal, (3) mechanical. The change has brought not only a more efficient production but also a relief from the drudgery and monotony which doubtless contributed to the encouragement of slavery.

Mechanization of agriculture has made the American farmer the most efficient farmer in the world. According to data compiled by the division of agricultural engineering, Bureau of Public Roads, U. S. Department of Agriculture, the estimated total primary horse-power available on farms increased from approximately seven millions in 1850 to nearly 47½ millions in 1924. The direct relationship between power used and the value of crops produced is strikingly shown in the following table.[2]

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[1] Paper read before Section M—Engineering, American Association for the Advancement of Science, Des Moines, Iowa, December 30, 1929.

Country or state	Primary power per agricultural worker	Value of crops produced annually
Italy	.19	$ 45.00
France	.37	90.00
Germany	.55	119.00
United Kingdom	.88	126.00
Alabama	.81	112.00
New York	1.69	250.00
Indiana	2.46	365.00
Iowa	3.86	595.00
Nebraska	4.71	910.00

According to Davidson,[3] the United States exports rice in increasing amount to China. Here we have the extreme in contrasts; rice production in China by hand labor at a low wage, fifteen cents a day, and rice production in California by machine methods with the highest-priced agricultural labor in the country, or fifty to sixty cents an hour with "found." The Chinese laborer boards himself. Is it reasonable to believe that engineering will continue to contribute to the progress and development of agriculture? Engineering more than any other factor has enabled the American farmer to compete with foreign competitors. A few years ago several German scientists visited this country, and the outstanding feature of their report on American agriculture was the large production per worker.

Nevertheless, the increased production per worker in agriculture has not kept pace with that of many of the other industries, and the return to the individual worker has been a problem which has received the serious attention of our federal government. In the final analysis, the returns per worker are of greatest importance in establishing a stabilized situation. The American Farm Bureau Federation has adopted the slogan, "A higher standard of living on the farm and an income from the farm to pay the bill."

Davidson has expressed the relationship by the simple equation, $I = (S - C)\ Q$, in which I signifies the income, S the selling and C the cost price of the farm produce and Q the quantity produced. Obviously I can be increased by increasing S or Q or by decreasing C. S is difficult to control especially when agricultural products are produced on some six million farms. Competition is severe in agriculture since we have not only the competition of individuals in our own country but also a stimulation of production in other countries. Prices raised by legislative action are likely to be short lived as a relief measure. Increased prices are always followed by increased production and land prices. Increased production usually leads to overproduction, a glutted market and falling prices. An increase in the efficiency of production probably offers one of the most encouraging possibilities of increasing the income of the individual.

This through the decrease of C or the increase of Q in the formula becomes, or may become, very largely a problem for the agricultural engineer.

The primary function of the agricultural engineer is to determine, recommend and promote the best solutions of engineering problems peculiar to the agricultural industries. His responsibility is—through modern operating equipment and practices—to aid in developing higher efficiency and greater productive capacity, thus making agriculture more profitable, lifting the burden of drudgery from agricultural people and raising their standard of living. Recognizing this, the American Society of Agricultural Engineers, as the national organization representing the agricultural engineering profession, has adopted the following platform as a statement of its objectives and of the principles and policies governing its activities.

"Engineering is the science of controlling the forces and utilizing the materials of nature for the benefit of man, and the art of organizing and directing human activities in connection therewith." Agricultural engineering deals with the application of the fundamental branches of engineering to the specific conditions and requirements of agriculture as an industry, as a mode of life and as a field of applied science. Subdivided on the basis of engineering technique, it now embraces (1) power and machinery, including rural electrification, (2) buildings and other structures, including sanitation, materials of construction and equipment, and (3) land reclamation, including irrigation, drainage, soil erosion control and other forms of mechanical improvement of agricultural lands.

An agricultural engineer is one who has been trained in both engineering and agriculture with experience in combining the two, and who is qualified to develop, design, organize and direct engineering work of or closely related to the agricultural industries.

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[2] Taken from Bul. 1348—U. S. Department of Agriculture, p. 17.

[3] J. B. Davidson, "Agricultural Engineering," *Journal of Engineering Education*, New Series, Vol. XIX, No. 3, November, 1928.

Agricultural engineering is fostered by land-grant institutions. Thirty-seven of forty-eight agricultural colleges in the United States provide agricultural engineering training to five thousand agricultural students annually. Technical engineers for this field are trained in seventeen of these institutions. Research work in this field is conducted by 103 full-time workers in thirty-four institutions.

FARM STRUCTURES

According to the latest census figures, the American farmer maintains a total investment in farm buildings of $11,750,000,000. How much it would cost to replace these buildings at the present time would be difficult even to guess. In order to maintain the buildings which he deems necessary for his farm, he spends several millions of dollars every day of the year. Unfortunately this money is often not well spent. Materials are frequently used where they are not at all suited, and sufficient consideration is not given to the actual requirements of the product housed.

With the recent agricultural depression the soundness of the farmer's investment has been seriously questioned, and since buildings appear to afford the easiest method of reducing his overhead, those in position to advise may have been guilty of preaching false economies in building construction. How many times has he been urged to reduce the cost of his buildings without due regard to the effect which this reduction might have on production or annual depreciation?

Industry buys equipment on a production cost basis. The ability of a given machine to bring returns is just as important a consideration as its original cost. A seemingly cheap machine may prove to be very expensive when its influence on production, labor, length of productive life and other factors are considered. Farm buildings constitute a part of the farmer's working equipment and deserve to be evaluated upon a production cost basis. The cost per quart of milk is more important than the cost per cow or the cost per barn. This attitude does not infer that we should neglect beauty or harmony in design, which have a very direct bearing upon morale, but that the emphasis should be put upon the securing of lower production costs by giving attention to management and fundamental housing requirements. The manner in which the farm building problem is handled is reflected in labor of operation, the quantity and quality of production and, in the case of stored products, the preservation for future needs.

One of the serious problems for farm management is that of labor. I am told that this is particularly true in the dairy industry. Recent studies show that the labor involved in dairying may be increased upwards of 30 per cent. by faulty arrangement of the barn and its relation to the other buildings in the farmstead. Fortunately it costs no more to arrange a barn efficiently. Often the saving in labor alone may be as large as the entire charge which may be placed against the dairy cow for rental.

If one expects to make dairying profitable, can he afford to neglect to plan the layout of his farmstead to assure efficiency in the use of labor?

The dairy cow is a warm-blooded animal. She may be likened to an engine operating under a fairly constant temperature. Fuel burned within the body generates heat which tends to raise the body temperature. She is provided with certain automatic means which dissipate this heat in order to keep the body temperature constant. Heat is radiated from the body surfaces. Moisture evaporated from the skin and thrown off by respiration carries off relatively large quantities of heat and helps keep the body temperature down. The rate at which this process goes on depends very largely upon the environmental conditions of air temperature, relative humidity and rate of air movement. If their combined effect is greater than the normal heat production of the body, more fuel must be consumed or body tissues destroyed to maintain comfort.

Experienced dairymen say that stable temperatures affect milk flow, and a cold spell may reduce the production by 5 per cent. or more. This reduction is frequently not temporary but continues throughout the current lactation period. Heavy feeding may prevent this reduction but is in itself an additional expense.

When it is considered that the total charge against the cow for housing is usually less than 10 per cent. of the total cost of producing milk, it may readily be seen that any attempt to reduce the cost of barn construction below the point where it satisfies the housing requirements may increase other cost factors more than is saved in building.

One might elaborate to show how buildings may affect returns in other lines. Egg production reflects the comfort of the birds. Grains are matured and preserved, horticultural products are kept in prime condition and the marketing period materially extended by proper housing. Whether it be housing live stock, grains, fruits or vegetables, there are definite requirements placed upon the building by the product itself which must be met if the building is to fulfil its obligation to the farmer. In general, these problems relate to the efficiency of operation, the maintenance of effective production and the preservation or conservation of farm products.

Unfortunately, many of the fundamental housing requirements are not definitely understood. The importance of the building has not been fully appreciated. The small, scattered units have not attracted sufficient competent study. The comparatively long life of the buildings tends to minimize interest in the study of the problem.

Buildings are frequently constructed of materials produced on the farm or purchased in a semi-fabricated condition. More careful attention is then required than would be necessary in the case of machinery which has been manufactured and assembled by specialists and comes to the farmer all ready for operation. If the farm housing problem is to be solved in a way that will bring commensurate returns and constitute an investment rather than a liability, it is necessary that there should be a careful analysis of building methods.

The three major factors of design, construction and maintenance claim our attention. Utility being paramount, we should know definitely the requirements placed upon the building by the products housed. What environmental conditions does the dairy cow need in order to produce milk most efficiently? How can we house the hen so that she will lay eggs when egg prices are favorable? Is ventilation necessary, and if so, how can it best be accomplished? What are the sanitary requirements for producing clean milk and maintaining a healthy herd? What insulation is advisable? How can the building be constructed most effectively and economically?

While it may be difficult to put a cash value upon beauty and harmony, they are very important items in maintaining a wholesome atmosphere on the farm. How can the farmstead be made attractive without adding unduly to the cost?

Methods of construction should be carefully studied in order to obtain a building which will provide these requirements at a minimum cost.

The influence of destructive agencies must be understood if we are to build in a way which will lower the depreciation cost.

Since little information is now available, the solution of these questions calls for an extensive research program. Evidently the farmer as an individual can not conduct his own researches efficiently. The small units and scattered field have not been generally profitable to the architect, and the farmer will not usually employ professional service. A program of this kind is logically the responsibility of publicly supported agencies such as the land grant colleges and the U. S. Department of Agriculture.

POWER AND MACHINERY

The agricultural industry is a tremendous user of power. However, the nearly 50,000,000 horse-power available is not being utilized to its greatest efficiency. Engineering attention is necessary if we are to secure lower production costs through the more economical use of power. Farm equipment design and the mechanization of farm operations now done by hand offer possibilities which challenge the best effort. There has been great progress in the harvesting machinery, but much still remains to be done. The use of electricity as an agricultural power has gained considerable prominence recently. Much investigational work is now being conducted to find the most practical methods of using electrical equipment.

LAND RECLAMATION

The agricultural engineer is interested in the improvement of land in so far as such improvement leads to lower cost of production. At the present time this means chiefly the improvement of land already being cultivated. Often economical cultivation is prevented by wet spots, open ditches, stumps or other conditions that prevent effective tillage or occupy land that otherwise could be cultivated.

Five types of problems are included: protection against stream overflow, drainage of wet land, irrigation of dry land, control of soil erosion, clearing of land obstructed by stumps or stones.

The agricultural engineer, as the term implies, is active primarily in the engineering relationships of agriculture. That engineering has had a profound and far-reaching influence on many of the developments in agriculture, especially during the past twenty years, is widely recognized. Engineering has been responsible, in a large measure, for creating a situation in agriculture comparable to that in manufacturing fifty years ago, when great industrial development in America had its real beginning. The evolution now going on in the agricultural industries emphasizes the importance of the engineering relationships and the increasing engineering responsibilities. The American Society of Agricultural Engineers therefore has pledged its activities to the further development and strengthening of the engineering relationships in agriculture and to the adaptation of the science and art of engineering to agriculture, to the end that the people engaged in farming may have increasingly better means for achieving a more stable prosperity and higher standards of living.

THE GOVERNMENT MAPPING PROGRAM IN A MAP-MINDED AGE[1]

By Professor J. S. DODDS

IOWA STATE COLLEGE, AMES, IOWA

NOT so many years ago a traveler going from one city to another pulled up his horses and asked the way whenever he became the least bit uncertain about the road. To-day a young man driving from one seacoast to another looks at his map of the airway as he passes over city after city without stopping except to refuel.

Can you imagine this present-day driver stopping to ask the way?

Whether in the air or on the highways or even on the water this motor-carried people uses maps as an aid to fast, sure travel.

Of course maps have been used and made by adventurers of all ages since first recorded history. There was a wonderful collection of maps in the library of Alexandria three thousand years ago. There are some fine examples of early cadastral maps on clay tablets in the British Museum which are more than four thousand years old. About six thousand years ago maps were made in Babylonia for taxation purposes.

These early maps were used mainly by explorers and scientists, but long before that time rude sketches on bark or sand or in mud or on walls were used by savages to convey ideas. It is this fact, that the untutored mind grasps ideas when presented in map form, which makes the maps of to-day so widely useful. They are still easily understood by all degrees of mentality. Even a four-year-old can learn facts from maps before she can read words.

No one can name all the present-day uses of maps. I quote from Colonel Robert R. McCormick, editor of the Chicago *Tribune*, to illustrate the general appreciation of the value of maps to-day.

> ### A HUNDRED THOUSAND MEN COULDN'T HAVE GIVEN US WHAT THE MAP SHOWED INSTANTLY
>
> In the late war, we often had to fire on batteries hidden by hills and screened overhead by timber growth. A hundred thousand men and millions of shells couldn't have won us the chance to see that battery and adjust our fire. But a pin prick in a good map—a little figuring with ruler and pencil—and we commenced dropping shells on the battery!
>
> A proposition comes up to establish a new highway, barge line or air route. I might spend weeks plowing through books or visiting along the route, before I could form an opinion on it. But let me look at a few good maps showing physical features and economic resources along the route, and I can form a sound initial judgment as to prospects for success. The map has told me what I might have to send a dozen men to see.
>
> Distance—intervening mountains or oceans—obstacles of time and space that would block the efforts of a thousand men to see—all these are swept away when you consult a good map.
>
> You have the vision of thousands of aviators, scattered over thousands of miles, condensed on a single sheet. You can travel here and there—thousands of miles—in a fraction of a second. There before your eyes are the facts you want, without any non-essentials or obstacles obscuring your vision. And you can point out and prove to others instantly what you scarcely could hope to show in any other way.
>
> For accurate grasp of facts—for a quick road to sound decisions—for solving a multitude of problems in business, politics and pursuits of pleasure, I say: *Give me first a good map.*

This testimonial to the value of maps is just a sample of the present-day appreciation of maps.

Maps are used to illustrate the day's news. If Byrd flies over the North or the South Pole, his course is shown by a clear sketch map. Each week during the construction season the papers publish a progress map showing road conditions in our states. The location of detours and various road types is shown. No news story of a shooting or an automobile wreck or a fire is complete without its map with a cross marking the exact spot. The maps used in news stories are usually what might be termed sketch or outline maps.

Better maps drawn to a larger scale are used by travelers. It is a very common sight to see people passing along the highways sure of the way because alongside the driver sits another person watching the road map. This form of back-seat driving is approved.

Similar maps are used in aeronautics. Air navigation maps are made in strips showing the country along the flight course and for about eighty miles of width. They show all features of interest to the aviator, such as elevations of land, rivers, railroads, highways, cities and towns, landing fields, magnetic declination, and obstructions to flying such as transmission lines. In passing it may be said that these maps are compiled from such sources as are available and are far from adequate in many respects.

Similar maps are used by business executives in planning and executing sales campaigns. For such purposes outline maps showing various statistical matter are also used.

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[1] Paper presented before Section M—Engineering, American Association for the Advancement of Science, Des Moines, Iowa, December 30, 1929.

Maps are popular to-day with interior decorators. They are hung on the living-room walls. The type of maps used for this purpose might be called the illuminated map. You have seen them with ships on the ocean and fish looking out of the water and deer and bears in the woods and Indians and horses and cattle in view. Such maps are pictorial in character. This style map is also used in advertising to induce the traveler or sportsman to take an interest in the advertised region or product.

Newspapers take advantage of the wide-spread interest in maps by holding contests such as one recently put on by a Chicago paper for suggested new arrangement of the state boundaries to secure more equitable representation in the United States Senate. The author of this paper recently received a check for $100 for submitting such a map in the contest mentioned. The thousands of maps entered in that contest indicate the very general appreciation of maps.

The uses suggested so far in this paper, and only a very few have been listed, relate to a relatively low-grade or sketchy style of map. The purpose has been to show the wide-spread use of maps.

We now come to the specific uses of accurately made maps, maps prepared by engineers and used by engineers in their various enterprises. These uses will be considered in connection with a discussion of the various mapping agencies of the government and a brief review of mapping methods and the mapping program.

At this point it is well to mention that numerous agencies besides the federal government are in the business of preparing maps. These include various commercial map-selling organizations, state and local engineering organizations and the engineering forces of various industrial organizations. There is much evidence that the duplication of effort by these widely scattered mapping agencies, if saved, would more than pay for a well-considered governmental mapping program. It is also certain that if this wide diversity of mapping interests could know about and use all available mapping data, still more waste could be eliminated and money and time saved.

The following governmental agencies at Washington are users of maps: the Board of Surveys and Maps; Geographic Section Department of State; War Department—the General Staff M. I. D., Geographic Branch, Q. M. Corps, Construction Service, Chief of Engineers, Map Files, Intelligence Section, Reproduction Plant, Mississippi River Commission, Lake Survey, Air Corps, Bureau of Insular Affairs; Post Office—Topography Division; Navy—Hydrographic Office, Yards and Docks; Interior—General Land Office, Indian Service, Geological Survey, Reclamation Bureau, Park Service; Agriculture—Weather Bureau, Forest Service, Bureau of Chemistry and Soils, Soil Surveys, Biological Survey, Bureau of Public Roads, Division of Agricultural Engineering; Commerce—Aeronautics Branch, Bureau of Census Geographic Section, Foreign and Domestic Commerce Geographic Section, Coast and Geodetic Survey; also the Library of Congress; Government Printing Office, Superintendent of Documents; Interstate Commerce Commission, Map Section, Valuation, Land Section; International Boundary Commission, Canada; Federal Power Commission; Public Buildings and Public Parks; Pan American Union; District of Columbia, Assessor, Surveyor's Office, Public Library. The engineering forces of most of these governmental agencies are busy most of the time preparing and using accurate maps for specific purposes. It is the function of the Board of Surveys and Maps to correlate the various mapping activities to prevent overlapping and to eliminate waste by making the maps of each agency available to all the others. A complete topographic map of the United States is one of the crying needs of this generation, as most engineers know.

The federal government has been at work on a complete topographic map of territorial United States for more than fifty years. At the end of the last fiscal year, June 30, 1929, 43.6 per cent. of the United States had been mapped; 17,333 square miles were mapped during the year. There remains to be surveyed about 1,717,000 square miles of unmapped territory, and much of what was previously mapped is not up to standard. It is easy to see that at the present rate we can wait at least one hundred years for the completion of this mapping program. But the mapping program does not contemplate waiting one hundred years. Some years ago the Temple Act was passed which set twenty-five years as the limit. Several of those years have passed with no speeding up of the program. Now comes an administration familiar with the uses of and needs for topographic maps and insists on a program which if carried out will complete the topographic map according to present standards in eighteen years. The budget presented to Congress on December 4 by the president includes increased askings which have this eighteen-year program definitely in mind.

The complete topographic map of the United States is the work of two governmental services aided by various cooperating forces. The U. S. Coast and Geodetic Survey is engaged in mapping the coastal areas and a precise skeleton of first- and second-order triangulation and levels covering the interior. This work is briefly explained by Major Wm. Bowie, chief of the division of geodesy, U. S. Coast and Geodetic Survey:

> An organization to survey the coasts of the United States was formed in the early part of the nineteenth century and has, with only a short break, been in continuous existence. It was first called the "Coast Survey" and its activities were confined to the survey of the coast itself, the waters adjacent thereto and the small strip of land, a mile or two in width, extending back from the coast. All classes of work were done which were necessary for the construction of hydrographic or sailing charts. These classes consisted of the determination of latitude, longitude and azimuth, by observations on the stars, the measurements of base lines for the control of lengths of triangulation, triangulation extending from one astronomic station to the other, topographic surveys, hydrographic surveys to show the depths of the water, tidal observations, the direction and force of currents in tidal waters and determinations of the variation of the compass.
>
> At first the Coast Survey operated only on the gulf and the Atlantic coasts, but shortly after the Mexican War, when California was added to our area, operations began on the Pacific coast. Shortly after the middle of the past century it was found desirable to connect the surveys of the Atlantic and the Pacific coasts by an arc of triangulation in order that the hydrographic charts could be placed in their proper relation with respect to their initial meridian and the equator. This arc of interior work, which was completed about 1895, was found to be of so great a value to surveyors and other engineers in the interior of the country that the name of the organization was changed to that of Coast and Geodetic Survey and its functions were enlarged so that the bureau's work would cover the execution of control surveys throughout the country.

The interior control surveys, triangulation or leveling, executed by the Coast and Geodetic Survey, are rated as first and second order. The first-order triangulation is of such accuracy that the closing errors of the triangles are approximately one second on an average, with about three seconds maximum closing error. Distances can be carried across country, by first-order triangulation, with an error not above one part in 200,000.

Second-order triangulation has closing errors which average about two seconds with a maximum closing error of about five seconds. Distances can be carried across country by second-order triangulation with errors seldom greater than about one part in 100,000.

First-order leveling, the most accurate used, has corrections of less than 0.15 mm per kilometer to close circuits. As a matter of fact, the average correction per kilometer is about 0.11 mm. This average correction is equivalent to 0.0006 feet per mile.

The Coast and Geodetic Survey is working towards the plan of having first- or second-order triangulation and leveling spread over the country to such an extent that the lines of leveling and arcs of triangulation will be spaced about 50 miles apart. The triangulation will be rigidly adjusted and final positions given to the several stations. The leveling also will be adjusted into the continental net, and the elevations furnished to the engineer will be referred to mean sea-level and will be standard or final. Intermediate areas will be filled in with control data by the U. S. Geological Survey.

The Coast and Geodetic Survey has a great spirit of loyalty among its personnel and a remarkable record for accuracy and scientific accomplishment. The topographic map itself is made in sheets of convenient size covering fifteen minutes of arc in latitude and longitude, or about thirteen miles by seventeen miles in this latitude, and made to a scale of one inch to one mile, or one to 62,500, and showing contours at twenty feet intervals. The surveys are made and maps prepared by the U. S. Geological Survey. The work is of a lower order than the network of first- and second-order surveys. The field work is carried on with great speed and efficiency.

Some of the earlier maps are now out of date on account of many natural and artificial changes in the surface features of the mapped areas. Many of these sheets were prepared in cooperation with local and state agencies and according to slightly varying standards, depending upon the purpose in the minds of the cooperating authorities.

It is now proposed to bring those sheets, which are obsolete, up to date and to map completely the remaining area without state or local aid except in cases where special conditions require expenditures in excess of the cost of the standard topographic sheets. These sheets are made according to standard regulations, and while they do not show 100 per cent. detail like a photographic mosaic, they do show surface conditions as engineers are accustomed to show them on maps of such a scale. Aerial photographs are now used as an aid in filling in topographical details. The air corps has cooperated in furnishing these.

In addition to the standard maps, special forms are prepared for individual purposes. For example, maps have been prepared of swampy regions in Florida and Wisconsin from aerial photographs showing all surface features but without contours. In 1928 a shaded relief and highway map of New Hampshire was compiled.

Other sheets have been prepared in cooperation with cities to show complete details to a large scale for use in city and regional planning or tax assessment work.

Strip maps have been made of areas connecting certain distant points. These maps show all features of importance in a study to determine the most feasible route between terminals. The route may be for a railroad, highway, canal or transmission line.

Taken as a whole, the topographic maps are of major importance in planning engineering projects and securing their efficient and economic operation. These projects include tunnels, bridges, city surveys and planning, highway development and extension, irrigation projects, hydroelectric developments, improvement of rivers for navigation, flood control of rivers and general topographic surveying and mapping where a knowledge of elevations and geographic positions is required. In fact, there is scarcely any human activity of an extensive nature that does not need for its proper execution a very accurate knowledge of the elevation and slope of the ground and the accurate distances between points.

All these activities are customarily started with a survey and the production of a map or maps. With a topographic map available any such project can be started without the expense of preliminary surveys. Any details needing amplification can be quickly and economically added to the standard sheets or to photostatic enlargements by taking them into the field as a plane table sheet or by comparing them with a set of quickly secured aerial photographs.

Paper locations are rapidly and economically made on standard topographic maps, and safe preliminary estimates are easily made therefrom. Such maps disclose valuable information to the geologist, mining engineer, soil surveyor, regional planner, valuation engineer, forester, realty appraiser, hydraulic engineer and practically all the fifty-seven varieties of engineers who practice "the science and art of directing the application of the science of mechanics in the economic utilization of the forces and materials of nature."

The government mapping program contemplates making such a standard topographic map available for the whole territorial United States in less than two decades. This is a consummation devoutly desired and urged by engineers and engineering societies throughout the country for many years. We can not afford to be without it. As Major Bowie says, "A large paper could be written on the use of surveying and mapping to eliminate waste in industry."

The estimated cost of this program is $5,000,000 for the control surveys and $50,000, 000 for the mapping, or about one fifth of what the United States expects to save on naval expenditures by participation in the London conference.

The following states are completely mapped: Connecticut, Delaware, Maryland, Massachusetts, New Jersey, New York, Ohio, Rhode Island, West Virginia and the District of Columbia. These states have shown their appreciation of the topographic map by furnishing funds to insure completion.

The European countries are ahead of us in the matter of map appreciation. This is probably due to the importance of maps in connection with wars and the tourist trade, apparently the two principal occupations of much of Europe. Those who travel must know their Baedeker. Those who fight must have maps to plan their campaigns. The close-knit European countries have long been completely mapped, but you will note that the more thickly populated of our states are also mapped.

The writer wants to interject a thought here that for present-day needs it may be desirable to raise the standards of the topographic sheets to provide a larger-scale map with perhaps five-foot contours and still greater accuracy of detail. It is a fact that the present standard map, while of almost incalculable value, is nevertheless on such a small scale as to be in effect practically a sketch.

It may be that with the advantages of present-day aerial methods the same estimated expenditures will provide a higher standard for future maps with a resulting greater usefulness and further elimination of waste.

We are living in an age when maps are a basic need. Our engineers have long appreciated the value of good maps. It looks as if our government had reached the stage when it too realized the importance of maps in the economical conduct of affairs.

If Congress carries out the provisions of the Temple Act we will have in the next eighteen years a complete topographic map of the United States at a cost of less than a tenth of our annual expenditure for the military establishment or one tenth of the special appropriation for new cruisers.

OBITUARY

JAMES ARTHUR HARRIS

JAMES ARTHUR HARRIS died at Minneapolis, on April 24, following an operation for appendicitis. He was born on September 20, 1880, at Plantsville, Athens County, Ohio, son of Jordan Thomas and Ida Ellen (Lambert) Harris. His parents having moved to Kansas he entered the university at Lawrence and graduated there with the degree of A.B. in 1901. Going to St. Louis, he was botanical assistant at the Missouri Botanic Garden from 1901 to 1903 (working in the summers at Lawrence) and librarian of the garden from 1904 to 1907. Meanwhile he had taken his Ph.D. degree at Washington University. From 1903 to 1907 he was instructor in general biology there. In the latter year he became investigator at the Station for Experimental Evolution (Carnegie Institution of Washington) at Cold Spring Harbor, Long Island, and continued there for seventeen years. In 1924 he was called to the chair of botany at the University of Minnesota where, as head of the department, he developed it in masterly fashion.

From the time of his attachment to the Carnegie Institution, Harris spent some time in other institutions and in the field. During 1908-09 he studied biometry under Karl Pearson at London. In the winters of 1912-13 he worked at the Desert Laboratory, Tucson, of the institution, and thereafter spent winter months at Tucson, at Jamaica, South Florida, and, in collaboration with the Bureau of Plant Industry, in the cotton experimental fields of the Southwest. This last work he continued after going to Minnesota. The Weldon medal and memorial prize of the University of Oxford were awarded to him in 1921.

Harris was one of the most industrious of investigators and prolific of writers in biology. Not infrequently he published fifteen or more papers in a single year. These covered a great range in detail, but fell into the following general classes: ecology, experimental evolution, biometry. His first paper, published in Kansas, 1900, was an annotated "Catalogue of the Crayfishes of Kansas," and this was followed by several papers on the crayfishes, culminating in his "Ecological Catalogue of the Crayfishes belonging to the genus Cambarius, 1903," which was, apparently, his doctor's thesis. In 1901 he published his first botanical paper ("Normal and Teratological Thorns of Gleditschia"). In 1903 he published on floral abnormalities and this topic interested him for many years; it led him particularly to consider the subject of variation in seeds in capsules. He became much interested in the pure-line theory and tested it out with beans. This led him to grow over a million seedlings. He discovered biotypes that had extra cotyledons.

A second series of papers grew out of his ecological interest. With R. A. Gortner he worked out a method of determining density of plant saps. This led to observations in the tropics and elsewhere and to the discovery of the greater sap density of parasitic plants over their host plants. It led to a study of the chemical differences in races of cottons corresponding to their morphological differences.

The third great interest of Harris was biometry. He had the statistician's love of numbers and he applied the Pearsonian methods to a great variety of animal and plant data, such as the egg laying of fowls, basal metabolism in man (with F. G. Benedict), and seedlings of the bean. His biometric work led him to work out new formulae of which many are of particular interest to geneticists.

Through all of Harris's work runs evidence of his interest in problems of evolution. He published not only on organisms in relation to environment, but also repeatedly on natural selection and on assortative mating (in man).

Of the personal traits shown by Dr. Harris, unlimited industry is one of the most striking. He never spared himself, and on one occasion when the nature of his research demanded continuous observation he worked during the midnight and early morning hours throughout the winter. He organized a biometric laboratory at Cold Spring Harbor and supervised the work of a large corps of assistants. In the field his energy was boundless. At Minneapolis he catalyzed a somewhat dormant botanical group, so that his department soon rose to a high rank. Harris had remarkable social traits. He inspired loyalty in his associates in the laboratory and in the field. His hospitality, with that of Mrs. Harris, was unbounded, and their home was the center of many social meetings of his associates. He was particularly happy in his married life. Mrs. Harris (Emma Lay) was also a naturalist. They had four sons in whom the family traits will, we feel sure, be continued. But the numerous societies in which he participated, often as officer, will miss him sorely. The loss brought by his death to his scientific associates will be only second to that suffered by his family.

C. B. DAVENPORT

RECENT DEATHS

DR. ALLERTON SEWARD CUSHMAN, chemist and founder of the Institute of Industrial Research in Washington, died on May 1, at the age of sixty-two years.

DR. CHARLES FRANCIS MCKENNA, consulting chemist of New York City, died on April 25, at the age of sixty-nine years.

MEMORIALS

A CENTENNIAL anniversary dinner in memory of the late Dr. Abraham Jacobi, who was born on May 6, 1830, and died on July 10, 1919, was held on May 2 at the New York Academy of Medicine. Professor Franz Boas, of Columbia University, was chairman of the committee of arrangements. The speakers announced were Dr. J. A. Hartwell, Dr. William H. Welch, Dr. Fielding Garrison, Miss Lillian Wald and Mr. George McAneny. Dr. Mary Putnam Jacobi, widow of Dr. Jacobi, was expected to attend. Dr. Jacobi became in 1860 the first professor in America of diseases of children, a subject which he taught for nearly fifty years.

A tablet in memory of Dr. John E. Sweet, professor of mechanical engineering at Cornell University from 1872 to 1879, was unveiled on April 5 at the Engineers' Club, New York. The tablet is the gift of the American Society of Mechanical Engineers in tribute to one of its founders and presidents. Dr. Sweet, who died May 8, 1916, was the inventor of the straight-line engine and, at the time of his death, one of the most widely known mechanical engineers in the United States.

SCIENTIFIC EVENTS

EXHIBIT OF WEIGHTS AND MEASURES AT THE SOUTH KENSINGTON MUSEUM

A new and permanent exhibition has been opened at the Science Museum, South Kensington, to illustrate the historical development of standards of weights and measurement. The London *Times* states that the exhibit occupies the whole of the entrance hall facing Imperial Institute Road and the long ground-floor gallery which leads into it. In the vestibule is a series of instruments arranged to display the principles of the equal-arm balance, the steel-yard and the more complicated recent mechanisms which extend the applications of the lever principle.

The earliest exhibit is an authentic Egyptian equal-arm balance of 1350 B. C., with a wooden beam and a cord pivot suspension, such as is still used in the bazaars of India and in China. One of the original stone weights accompanies it. A Roman bronze balance and steel-yard are shown (both in replica), and a number of glass weight standards of the Early Middle Ages. The methods of suspension by cord, by the less accurate ring device, by the gallows-and-pin, and by the knife-edge are shown both in the working specimens and in a series of transparencies in the adjoining gallery, while a number of skeleton models designed by Mr. W. A. Benton, of the Avery Historical Museum in Birmingham, display upon a small scale the various improvements made within the last few centuries to allow large weights to be measured with great speed and accuracy.

Certain turning-points, such as the Roberval "static enigma" of 1669 and Wyatt's cart-weigher of 1740, have affected the whole of modern practice in large-scale weighing machines, but though the models of these are interesting more attention perhaps will be drawn by Mr. Benton's reconstruction of the two self-indicating balances designed by Leonardo da Vinci in a manuscript now in the Bibliothèque Nationale.

The companion collection of instruments of measurement is of more recent date, since the invention of the micrometer can not well be traced beyond William Gascoigne's micrometer designed in 1639 for astronomical purposes. Important instruments such as Watt's eighteenth-century micrometer, Whitworth's measuring machine of 1855 (the first to indicate a millionth of an inch) and the comparators recently developed by the National Physical Laboratory through the use of a beam of light, can be seen and demonstrated in the gallery. Three important standards of length lent by the Royal Society are Graham's standard yard of 1742, Bird's standard 90 inches of 1750 and Shuckburgh's 5 ft. standard of 1796. It was by the use of these that the Standards Commission of 1843–55 was able to connect the standards now in use with the Elizabethan yard, after the destruction of the Imperial standard in the 1834 fire at the Houses of Parliament.

THE PROPOSED MEDICAL CENTER IN BROOKLYN

At the semi-centennial dinner of the Alumni Association of the Medical School of the Long Island College Hospital plans were announced on April 26 for the establishment of a medical center in Brooklyn, N. Y. The plan, which includes separation of the Long Island College Hospital from its Medical School, calls for the organization of a new medical college to be associated with nine Brooklyn hospitals. The physical equipment of the combined units will cost more than $100,000,000.

The new institution, for which a board of trustees has already been chosen, will apply shortly for a charter as a medical college. It has voted the first $500,000 toward an endowment fund to meet the educational law requirements for the organization of a collegiate institution in New York State.

Dr. James C. Egbert, president of the medical school that is being discontinued, is a member of the board of trustees of the new institution.

The plans for the college include the erection of a central building which will be located in mid-Brooklyn and which will be easily accessible to the hospitals involved in the plan. The site has already been selected. The building which is to be erected within the next five years will cost, according to an estimate made by Dr. Egbert, more than $3,000,000. The plans of the board also call for an immediate endowment fund of at least $1,000,000.

The central plant and its affiliated hospitals will take care of at least 400 medical students. Courses in the first two years will be given at the central building. In the last two years students will receive instruction at the central plant and at the affiliated hospitals.

Of these hospitals four will have intimate contact with the college and be represented on its board. They are the Brooklyn, Methodist Episcopal, Jewish, and the Long Island College Hospital. The present teaching arrangements with the city hospitals in Brooklyn, including use of clinical material by the third and fourth-year students, will be maintained.

THE SUMMER MEETING OF THE SOUTHERN DIVISION OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

The Southern Division of the American Phytopathological Society will hold its annual summer meeting from June 11 to 16. The arrangements for the field tour are under the direction of Dr. L. E. Miles, *chairman,* and L. M. Fenner, *secretary.* The group will assemble at the Walthall Hotel in Jackson, Mississippi, during the evening of June 11. On June 12, an early departure will be made southward to the truck crop areas around Crystal Springs and Hazlehurst. This is the center of the fresh tomato district. Field operations, grading and packing may be observed. Tomato shipments will be at the peak. In the field, observations are being made on the overwintering of bacterial canker of tomato and other tomato diseases. Diseases of beans, carrots, cotton and sweet potatoes will be noted here and in the coastal area. Search is being made for the newly discovered phony peach disease. Departing from the famous health resort at Browns Wells on June 13, visits to pecan groves and nurseries will be made, and the work of the South Mississippi Experiment Station at Poplarville will be noted. Citrus, figs, grapes, peaches, sugar cane and gladiolus will be of interest here. From Hattiesburg on June 14, the tour will include diseases of citrus, pecans and sugar cane, arriving in Biloxi late that afternoon. Visits to truck crop areas, nurseries and to the pecan station will be made on June 16.

For members interested in the collecting of fungi, this tour should afford an opportunity for gathering unusual specimens. The winter and spring seasons have been cool and rainy over much of the state and the conditions may favor a considerable number of plant diseases.

The State Plant Board of Mississippi and the Agricultural Experiment Station have tendered their services in making the tour available to visitors who may come by train. All members, visiting scientists and agricultural workers interested in plant diseases and their control are extended a cordial invitation to meet with the society. Requests for reservations should be addressed to the committee at A. & M. College, Mississippi.

AWARD OF THE MEDAL OF THE AMERICAN INSTITUTE OF CHEMISTS TO MR. EASTMAN

The American Institute of Chemists has awarded its medal "for noteworthy and outstanding service to the science of chemistry and the profession of chemist in America" to Mr. George Eastman. Dr. Frederick E. Breithut, president of the institute, has made the following statement:

> Mr. Eastman's research work toward simplifying and popularizing photography was begun in 1883 with his first attempts to make the now well-known roll film, and it was a chemical discovery—the use of nitro-cotton dissolved in the proper solvents—which marked the turning point of his career.
>
> One of the first buildings at Kodak Park was a chemical laboratory and throughout the entire development of his work, Mr. Eastman has always availed himself of the services of trained chemists, and of whatever chemical processes could in any way be useful in his projects. A research laboratory, one of the greatest in the country, was established in 1912 to deal specifically with the fundamentals of photography, and to carry on investigations along all lines of interest to the company. Its accomplishments, in chemistry and physics as well as in photography, were so effective that at present the Eastman Kodak Company is practically a self-contained chemical manufacturing concern. It operates plants for the manufacture of its own acids, silver salts, solvents, gelatine, large-scale production of cellulose nitrate and acetate for all kinds of films, and a unique mill for photographic paper.
>
> The most noteworthy service to American chemistry in Mr. Eastman's career was made in 1918 when he approved the establishment by the Research Laboratory of a department of synthetic organic chemistry to manufacture and supply the various synthetic organic chemicals required for research purposes in the United States. The primary object of this much-needed move was to insure the complete independence of the United States in regard to these essential materials, and it received the cooperation and active support of both industrial and academic chemists throughout the country. Continued cooperation with all available sources of supply and an active production program have increased the number of available chemicals to over 2,600—a number of high quality organic chemicals greater than that of any other country. The value of this work was recognized publicly when the Synthetic Organic Chemical Manufacturers Association, in 1925, made Mr. Eastman an honorary member.
>
> Mr. Eastman has always recognized the great value to him of the chemists of the country and of the institutions in which they were trained. His gifts to the Massachusetts Institute of Technology may perhaps be taken as a direct tribute to the chemists and engineers who came from there to assist him in the building up of his great business. In all, over sixty million dollars have been given by him to educational institutions, especially to the

Massachusetts Institute and to the University of Rochester.

The history of the Eastman Kodak Company shows what the application of chemical research can mean in the creation of new wealth in vast amounts. Many of our backward industries could profit by a study of Mr. Eastman's methods. Some of those industries do not yet comprehend what he understood forty years ago. Mr. Eastman learned to apply chemistry to the control of the transformation of the materials which he used, and that knowledge has been applied by him, through the photographic science and art which is now a part of our daily life, to create not only wealth, but service and happiness for all mankind.

SCIENTIFIC NOTES AND NEWS

AT the concluding session of the sixty-sixth annual meeting of the National Academy of Sciences on April 30 the following were elected to membership: Dr. C. A. Adams, professor of electrical engineering and dean of the engineering school, Harvard University; Dr. J. W. Alexander, professor of mathematics, Princeton University; Dr. Eugene T. Allen, research chemist, Geophysical Laboratory of the Carnegie Institution of Washington; Dr. Harry Bateman, professor of mathematics, physics and aeronautics, the California Institute of Technology; Dr. Isaiah Bowman, director of the American Geographical Society; Dr. G. P. Clinton, botanist, Connecticut Agricultural Experiment Station, and research associate in plant pathology, Yale University; Dr. William Weber Coblentz, physicist, Bureau of Standards; Dr. Paul S. Epstein, professor of mathematical physics, California Institute of Technology; Dr. Vernon Kellogg, secretary of the National Research Council; Professor Frederick G. Keyes, in charge of the chemical department of the Massachusetts Institute of Technology; Dr. K. S. Lashley, professor of psychology, the University of Chicago; Dr. Berthold Laufer, curator in anthropology, Field Museum, Chicago; Dr. S. C. Lind, director of the School of Chemistry, University of Minnesota; Dr. Frank E. Ross, astronomer at the Yerkes Observatory; Dr. A. H. Sturtevant, professor of genetics, California Institute of Technology. Dr. R. A. Millikan, of the California Institute of Technology, was reelected foreign secretary of the academy for a term of four years. Dr. Karl T. Compton, of Princeton University, was elected a member of the council, to succeed Dr. George E. Hale, and Dr. J. McKeen Cattell, editor of SCIENCE, was reelected for a term of three years.

AT the dinner of the National Academy of Sciences, held in Washington on April 29, the medals of the academy were presented as follows: The Mary Clark Thompson Medal for the most important services to geology and paleontology to Professor William Berryman Scott, Princeton University; the Agassiz Medal for oceanography to Dr. Johannes Schmidt, director of the physiological department of the Carlsberg Laboratory of the University of Copenhagen; the Daniel Giraud Eliot Medal and Honorarium for the most meritorious work in zoology or paleontology for 1927 to Dr. Erik H. O. Stensiö, of the Royal State Museum of Natural History, Stockholm, and for 1928 to Ernest Thompson Seton, for his book on "Lives of Game Animals." The Public Welfare Medal had been awarded before his death to Stephen T. Mather, organizer and director of the U. S. National Park Service.

AT the annual meeting of the American Philosophical Society members were elected as follows: Dr. Norman L. Bowen, petrologist, Geophysical Laboratory, Carnegie Institution; Admiral Richard E. Byrd, Boston, Massachusetts; Cyrus H. K. Curtis, The Curtis Publishing Company, Philadelphia; Dr. Harvey Cushing, Moseley professor of surgery, Harvard Medical School; Mr. Francis Irénée du Pont, E. I. du Pont de Nemours and Company; Raymond Blaine Fosdick, lawyer, trustee of the Rockefeller Foundation and of the General Education Board; Mr. Thomas Sovereign Gates, banker, trustee of the University of Pennsylvania; Mr. William Guggenheim, New York City, manager of the Guggenheim mining and smelting interests in Mexico; Dr. Solomon S. Huebner, professor of insurance and commerce, the University of Pennsylvania; Mr. Archer Milton Huntington, author, New York City; Dr. Merkel Henry Jacobs, professor of general physiology, University of Pennsylvania; Charles Franklin Kettering, president of the General Motors Research Corporation, Dayton, Ohio; Alfred Lee Loomis, banker, director of the Loomis Laboratories for Physics at Tuxedo Park, New York; James Brown Scott, president of the Institution of International Law, Washington, D. C., and trustee and secretary of the Carnegie Endowment for International Peace; Dr. Frederick Tilney, professor of neurology, Columbia University; Dr. Alexander Wetmore, assistant secretary of the Smithsonian Institution. Foreign residents were elected as follows: Professor Albert Einstein, University of Berlin, and Dr. John Stanley Plaskett, director of the Dominion Astrophysical Observatory, Victoria, B. C.

A FRANKLIN MEDAL of the Franklin Institute has been awarded to Sir William Bragg, Fullerian professor of chemistry at the Royal Institution and director of the Faraday Research Laboratory. A dinner in his honor and in honor of other medalists of the institute will be given in Philadelphia on May 21.

DR. FAY-COOPER COLE, chairman of the department of anthropology at the University of Chicago, has received the gold medal of the Chicago Geographic Society for his anthropological researches. The presentation speech was made by Dr. James Henry Breasted, director of the university's Oriental Institute, who received the same honor in 1929 for research in Egypt and the Near East. Dr. Cole's ethnological investigations have taken him into the Philippines, the Malay Peninsula, Sumatra, Java and Borneo.

THE Leslie Dana Medal for the prevention of blindness has been awarded to Dr. George E. de Schweinitz, professor emeritus of ophthalmology at the University of Pennsylvania.

DR. H. L. FAIRCHILD, emeritus professor of geology at the University of Rochester, celebrated his eightieth birthday on April 29.

AT the meeting of the American Association of Pathologists and Bacteriologists held in New York on April 17 and 18 the following officers were elected: *President,* George R. Callender; *Vice-president,* Ward J. MacNeal; *Treasurer,* F. B. Mallory; *Secretary,* Howard T. Karsner; *Incoming member of the council,* O. T. Avery; *Assistant Secretary,* Robert A. Moore. For distinguished service in pathology and bacteriology, the gold-headed cane of the association was presented to Dr. Theobald Smith. The association will meet next year at Western Reserve University on April 2 and 3.

AT Harvard University the following promotions have been made to professorships: Leigh Hoadley, zoology; E. A. Hooton, anthropology; Marston Morse, mathematics; H. H. Plaskett, astrophysics; to associate professorships, Kirk Bryan, physiography; H. A. Frost, architecture; J. L. Walsh, mathematics.

DR. H. J. WILKINSON, formerly senior demonstrator of anatomy at the University of Sydney, has been appointed professor of anatomy at the University of Adelaide, Australia. During the past eighteen months Dr. Wilkinson has been a fellow of the Rockefeller Foundation, working on the innervation of skeletal muscle in the laboratories of Boeke in Utrecht, Agduhr in Upsala and Ranson in Chicago.

DR. WARD B. WHITE, director of the New York State Bureau of Chemistry, has accepted the position of chief of food control, Food and Drug Administration, U. S. Department of Agriculture, effective on June 2. This appointment is to fill the vacancy caused by the death of Dr. R. W. Balcom.

DR. ROBERT HEGNER, who has served for the past school year as visiting professor and head of the department of parasitology in the school of Hygiene and Public Health of the University of the Philippines, has returned to the Johns Hopkins University.

DR. ERNEST CARROLL FAUST, professor of parasitology in the College of Medicine, Tulane University of Louisiana, will spend the months of June, July and August as visiting investigator at the Gorgas Memorial Laboratory. He will take with him two young New Orleans physicians. The group will associate themselves with Dr. Herbert C. Clark, director of the laboratory, Dr. John Miller, pathologist, and Major L. H. Dunn, entomologist, in the study of the significance of amebiasis and of nematode infections in man and monkeys in the Canal Zone.

DR. DAVID I. MILLER, government entomologist of New Zealand, recently spent several days in conference with the entomologists of the U. S. National Museum while on his way to Europe.

IT is announced at the Smithsonian Institution that John P. Harrington, of the Bureau of Ethnology, returned to Washington on April 26, after eleven months of field study among the Karuk and San Juan Indians of California, and that Dr. J. W. Gidley, of the U. S. National Museum, left Washington on May 1 to continue work begun in Idaho last summer in the Snake River Valley.

FATHER BERARD HAILE, Franciscan monk and for twenty years missionary among the Navajo Indians of Arizona, has joined the scientific staff of the University of Chicago as research associate in anthropology. He will spend the coming summer tenting among the Apaches of New Mexico, equipped with a phonograph for recording their language and music.

THE Ottley-Anthony South American Expedition of the American Museum of Natural History has returned to New York after a sojourn of six months in the field. The expedition was undertaken primarily to make a reconnaissance over a very wide area for the purpose of future collecting. In this it was successful, as well as in the collection of a representation of the mammals from the various localities. During the trip the party crossed the Andes no less than six times, and visited six of the South American republics. The expedition was made possible through the generosity of Mr. Gilbert Ottley, who acted as field assistant to Mr. H. E. Anthony, curator of mammals, in charge of the expedition.

The members of the new administrative board of the American Engineering Council include, in addition to the president, Mr. Carl E. Grunsky, of San Francisco, the following vice-presidents of the council: L. P. Alford and L. B. Stillwell, New York; O. H. Koch, Dallas, Texas; G. S. Williams, Ann Arbor, Michigan. The following representatives of the constituent organizations of the council were also appointed to the board: American Institute of Chemical Engineers—Dr. H. E. Howe, Washington, D. C.; American Institute of Consulting Engineers—Edwin F. Wendt, Washington, D. C.; American Institute of Electrical Engineers—C. O. Bickelhaupt, Atlanta; H. A. Kidder, New York; R. F. Schuchardt, Chicago; Professor C. F. Scott, Yale University; C. E. Skinner, East Pittsburgh, Pennsylvania; American Society of Agricultural Engineers—Professor William Boss, University of Minnesota; American Society of Civil Engineers—H. S. Crocker, Denver; A. J. Dyer, Nashville; Dean Anson Marston, Iowa State College; Frank M. Williams, Albany, New York; American Society of Mechanical Engineers—John Lyle Harrington, Kansas City, Missouri; John H. Lawrence, New York; General R. C. Marshall, Jr., Chicago; Charles Piez, Chicago; E. N. Trump, Syracuse; D. Robert Yarnall, Philadelphia. The following representatives from regional districts were named: George A. Reed, Commissioner of Public Works, Montpelier, Vermont; Burritt A. Parks, Grand Rapids, Mich.; Professor J. S. Dodds, University of Iowa; C. B. Hawley, Washington, D. C.; A. A. Krieger, Louisville, Ky.; W. W. Horner, St. Louis, Mo.

Dr. John R. Mohler, chief of the Bureau of Animal Industry of the Department of Agriculture, has been appointed chief of the delegation which will attend the International Veterinary Congress in London, August 4 to 9. The other American delegates are Dr. George H. Hart, of Davis, Calif.; Dr. Adolph Eichhorn, of the Lederle Antitoxin Laboratories, Pearl River, N. Y.; Dr. Charles H. Stange, dean of Iowa State College; Dr. W. E. Cotton, of Bethesda, Md.; Dr. A. T. Kinsley, of Kansas City, Mo., and Dr. J. F. Devine, of Goshen, N. Y.

Llewelyn Williams, assistant in wood technology on the staff of the Field Museum, Chicago, and leader of the Peruvian division of the Marshall Field Botanical Expedition to the Amazon, is expected back in Chicago about the middle of May. He has made collections of woods and other botanical material in the Amazonian forests of Peru, and explored some regions believed never before to have been entered by a white man. Mr. Williams has been in the field about one year. The other division of the expedition, which worked along the Amazon in Brazil under the leadership of Dr. B. E. Dahlgren, acting curator of botany, returned several months ago.

The eighth meeting of the Harvey Society, which will be the twenty-fifth anniversary meeting of the founding of the society, will be held at the New York Academy of Medicine, on Thursday evening, May 15, at eight o'clock. Dr. Rufus Cole will deliver an address on the progress of medicine during the past twenty-five years, as exemplified by the Harvey lectures, and the "Harvey Film," executed by Sir Thomas Lewis and Dr. H. H. Dale, will be shown.

Professor William J. Crozier, of the department of general physiology at Harvard University, delivered the Luther Laflin Kellogg Lectures at Rutgers University on April 20, 30 and May 1. The general subject of the lectures was "Aspects of Behavior," with the sub-headings, "Regularities in Living Systems," "Elements of Conduct" and "Mechanism and Behavior."

Colonel W. A. Starrett gave the fifth lecture in the Aldred Series at the Massachusetts Institute of Technology on April 25. He spoke on "The Business Aspects of the Modern Builder's Problem." After his lecture Colonel Starrett showed a motion picture of the construction of the Bank of Manhattan Building in New York City.

The eighteenth annual meeting of the Eugenics Research Association will be held at the Hotel McAlpin, New York, on the morning of Saturday, May 17. The presidential address will be given by Dr. Clarence G. Campbell, of New York, on "Human Evolution and Eugenics." The fourth annual meeting of the American Eugenics Society will be held in the afternoon. A luncheon and a dinner have been arranged.

The General Education Board of New York has given $500,000 to the Johns Hopkins Hospital and School of Medicine to be used for the completion of the William Osler Medical Clinic and the William Stewart Halstead Surgical Clinic.

Washington University (St. Louis) has received a gift of $240,000 from the Rockefeller Foundation. No restriction is placed on the use of the money, except that it be spent principal and interest over a period of seven years in research in pure as distinguished from applied science.

The Chicago Medical School has purchased from the Francis B. Willard Hospital the property at 710 South Lincoln Street. It will move into its new quarters during June, so that school will open in the new building next September. During the first month next fall, a homecoming day will be observed, with suitable exercises. This new property will give the school the opportunity for expansion which it has sought for several years. Its dispensary service will be enlarged and it will be able to undertake a series of research problems having to do with the cause, course and prevention of disease.

THE twelfth annual meeting of the American Society of Mammalogists will be held at the American Museum of Natural History, New York City, from May 21 to 24. The first three days will be devoted to the presentation of papers, included among which will be those comprising a symposium on the gorilla, arranged by Dr. William K. Gregory, and another on the utilization of zoological park collections for research, arranged by Dr. W. Reid Blair.

DURING the recent meeting of the Ohio Academy of Science, the committees appointed on March 8, at the joint meeting of the Akron Society of Applied Physics and the Central Ohio Physics Club, reported in favor of the formation of the "Ohio Physics Association," consisting of all local clubs and societies that are devoted to physics; and a news publication entitled *Physics News,* whose purpose will be to give personal, industrial and academic news to physicists. One of the purposes of the Physics Association is to edit this *Physics News* and to encourage and provide for joint meetings of various clubs; and to encourage formation of local physics clubs. It is felt that industrial and academic physics may be brought into a closer and better cooperation by such an association, and that high-school physics teachers may receive also some benefits thereof. The affairs of the Physics Association are to be carried on by an executive committee, composed of the last past president of the various clubs.

DISCUSSION

RENEWAL OF THE AMERICAN MUSEUM EXPLORATIONS IN THE GOBI DESERT

IN response to the article which appeared in SCIENCE, September 27, 1929, entitled "Interruption of Central Asiatic Exploration by the American Museum of Natural History," and also in response to letters addressed at the same time to the directors of leading institutions in Peiping (Peking), I have received as President of the American Museum of Natural History very courteous letters from three of the leading directors of Peiping institutions as follows:

The National Library of Peiping, Acting Director T. L. Yuan.

The Geological Survey of China, Director W. H. Wong.

The Committee for the Preservation of Ancient Objects, Chairman Tchang Ki; and the Chairman of the Peiping Branch, Dr. Ma Heng.

To these most welcome letters President Osborn sent the following reply in identical language to each of those institutions:

February the first,
Nineteen hundred thirty

DEAR SIR:

I acknowledge with pleasure the receipt of your letter of December 12th in reply to my letter of October 22nd and the copies of SCIENCE containing my official report. I am very glad to learn from the concluding paragraph of your letter of your friendship for the American Museum, of your interest in the scientific importance of our Central Asiatic Expeditions and your desire to do all within your power to enable the Expedition to resume its work next year.

The interruption of the Expedition has been a very great blow to the advancement of the sciences of geology and paleontology. It has entailed very serious financial loss to the American Museum of Natural History; it has been a severe disappointment to the two hundred and fifty-three subscribers to the Central Asiatic Expeditions in thirty-seven states of the Union. It has been a great disappointment to me personally for during my visit to Peking in 1923 I planned with Director V. K. Ting of the Geological Survey and Director Kung Pa King of the Art Museum and others to help build up a natural history museum in one of the palaces, to supply it with specimens of all kinds from our collections here but especially with duplicates from the Asiatic Expeditions.

The representatives of this Museum, Dr. Roy Chapman Andrews and Mr. Walter Granger, are men of the finest personal character, reputation and deportment who have been with me for thirty-nine years and twenty-one years respectively. All the representatives of all the American Museum Expeditions to all parts of the world bear official instructions to exercise great courtesy, integrity and fidelity to the customs and laws of the countries they visit.

Especially as regards human Archæology and original and historic monuments relating to the civilized history of man, the American Museum has strongly supported the laws of different countries both in the Old and New Worlds. We believe they should be kept in the countries where they are found provided that these countries have the means and the intention of preserving and caring for them as you are now doing in your honorable Society for the Preservation of Ancient Objects.

The American Museum and its representatives in every country have taken an entirely different ground towards geologic, palæontologic, and zoologic specimens. We have collected fossils in every country and we have welcomed students and explorers from every other country within our states and territories. From time immemorial scientific parties from other countries—from France, Germany, England and other European states—have been freely collecting fossils in America or freely purchasing them by export through dealers.

These fossils from India and China are generally found in a most fractured and imperfect condition and only through comparison in our Museum with other fossil and living specimens and through access to the vast literature of palaeontology and geology is it possible to determine what they are. I personally have labored for months with the greatest difficulty on the fossils received from the Central Asiatic Expedition and it is only my fifty years of study which have enabled me to correctly interpret those found in the first year before the completion of the United States Geological Survey Monograph which I am now sending to the National Geological Survey of China.

It is very rare that fossils have an intrinsic financial value. Their value comes only from the study which is put upon them. In this respect they differ entirely from archaeological specimens which often have immediate and great intrinsic value.

I hope in this spirit of a new understanding that the National Geological Survey of China will cordially support the renewal of the Central Asiatic Expedition and will trust to our fairness in having due regard to the advance of science in China and our integrity in carrying out our agreements along the lines which prevail in all the countries with which we are in cooperation for the advancement of geology and palaeontology.

Sincerely yours,
HENRY FAIRFIELD OSBORN,
President

DR. W. H. WONG, DIRECTOR
THE NATIONAL GEOLOGICAL SURVEY OF CHINA

On March 18, President Osborn received a cable from Dr. Andrews reporting on the result of his negotiations with Professor Ma Heng, Chairman of the Commission for the Preservation of Ancient Objects, requesting that the following announcement be made in SCIENCE:

> President Osborn is glad to announce that the difficulties regarding the work of the Central Asiatic Expedition have been satisfactorily adjusted. An understanding has been reached between both the Cultural Society and the Commission for the Preservation of Ancient Objects officially appointed by the Government of Nanking, with the American Museum of Natural History. Members of both the Cultural Society and the Commission for the Preservation of Ancient Objects are in sympathy with scientific men in other parts of the world and appreciate the importance for China and the world of science of mutual harmony, while maintaining for China a primary interest in its scientific treasures. The Central Asiatic Expedition and the Commission for the Preservation of Ancient Objects will cooperate in the coming expedition in results as well as in the scientific study of collections.

This message makes it clear that Dr. Andrews is now making ready to resume the work in Mongolia this season. Curator Walter Granger, chief palaeontologist of the expedition, now in the American Museum working up the 1928 collections, accompanied by Mr. Albert Thomson, assistant in palæontology, and Mr. J. McKenzie Young, head of the motor transport, are preparing to sail for China as early as they receive positive word from Chief Andrews.

On March 24 Andrews cabled that the agreement with the Cultural Society and the Commission for the Preservation of Ancient Objects had been signed by both parties, and Messrs. Granger, Thomson and Young are to take the quickest route to Peiping. This means that the expedition will be equipped and ready to start north into the Gobi Desert about May 1. This harmonious outcome of negotiations which have been in progress since August, 1928, will be extremely gratifying to geologists and paleontologists all over the world and will renew the cooperative relations between the American Museum and the scientific institutions of China.

Postscript, April 29: Dr. Roy Chapman Andrews cables that the Chinese Government of Nanking approves the recommendation of the Cultural Society of Peiping for the renewal for the fifth season of exploration in the Desert of Gobi succeeding the active seasons of 1922, 1923, 1925, 1928. Messrs. Granger and Thomson are due to arrive in Peiping on May 9 and Dr. Andrews cables that all the arrangements have been made to reenter Mongolia immediately.

The American Museum of Natural History desires to express to the Cultural Society, the Commission for the Preservation of Ancient Objects and to the Government of Nanking its appreciation of their liberal action in this matter and its desire to cooperate in the advancement of paleontology and geology in China as well as throughout the world.

HENRY FAIRFIELD OSBORN,
President

AMERICAN MUSEUM OF NATURAL HISTORY,
MARCH 24, 1930

AUSTRALOPITHECUS NOT A CHIMPANZEE

Australopithecus, the fossil juvenile anthropoid ape from Taungs, South Africa, has been a center of controversy ever since the preliminary description of the skull by Professor Dart in 1925. Opinions as to its position have ranged from the belief that it is close to the line of human evolution to the view that it is merely a young chimpanzee. Unfortunately, few who have discussed it have seen the original, and have based their opinions on photographs or somewhat inadequate casts.

During a recent visit to Johannesburg I had the pleasure, through the kindness of Professor Dart, of studying the specimen under the guidance of Dr.

Broom. I do not intend here to enter into a general discussion of the position of this interesting fossil, but wish merely to protest emphatically against its dismissal as "merely a chimpanzee." Certainly, of living anthropoid apes, the chimpanzee is the only one with which a comparison might possibly be made. Both Professor Dart and Dr. Broom, however, have pointed out many features in which this specimen differs from this living form. Direct comparison of the fossil with chimpanzee skulls of a similar degree of development renders it obvious that *Australopithecus* is specifically distinct, and generic distinction seems almost equally certain.

New light is now shed on the subject through the fact that Professor Dart has skilfully disarticulated the jaw, revealing the dentition in its entirety. A study of the teeth suffices to render the assignment of *Australopithecus* to the chimpanzees absolutely out of the question. The vertical position of the incisors as contrasted with the forward slope of those of the chimpanzee has been discussed by Dart and Broom. The canines are small as compared with the milk molars; these teeth are much larger than those of the chimpanzee and in their size, shape and structure appear to be outside the possible range of variation of that genus and, in fact, resemble more closely the human type.

Attempts to settle the phylogenetic position of *Australopithecus* might best be postponed until the publication of Professor Dart's monograph on the skull. But in the meantime it can not be too strongly emphasized that *Australopithecus* is not a chimpanzee, but a new and separate type of anthropoid ape, worthy of careful consideration in any discussion of higher primate phylogeny.

ALFRED S. ROMER

WALKER MUSEUM,
UNIVERSITY OF CHICAGO

STRIATED COBBLES FROM TEAY VALLEY, WEST VIRGINIA

THE occurrence of striated cobbles and boulders in regions south of the glaciated area has been discussed recently by Wentworth.[1] In examining gravels in Teay Valley, West Virginia, during the past summer the writer found striated cobbles in a new locality, and since their presence here sheds additional light on the origin of such cobbles and also on the problem of the diversion of the Kanawha River from its old course through Teay Valley, it is desired to put the facts on record.

Teay Valley has long been recognized as an abandoned river valley, having been first brought to attention by I. C. White in 1884 and described in some detail a few years later by G. F. Wright. In 1903 W. G. Tight discussed it in detail, showing its relation to other preglacial drainage lines. It is now generally accepted to be the abandoned channel of the Kanawha River, which deserted this northwesterly course for its present northward course.

Teay Valley is about a mile wide and thirty-five miles long, extending from St. Albans to Huntington. The Teay formation, which consists of gravel grading upward into finely laminated clay, was deposited in this valley. The striated quartzitic cobbles, ranging in diameter from two to ten inches, were found in exposures of the gravel in cuts made by the Chesapeake and Ohio Railroad about three miles east of Milton.

Three possible origins for striated cobbles south of the margin of continental glaciation have been suggested.[2] The lithology, location and association of the cobbles in the Teay formation make the hypothesis of intense valley ice action the most plausible explanation for their striation.

In order to explain the character and distribution of the clays of the Teay formation, Campbell[3] has suggested that local ice dams existed for some time, causing the ponding necessary for the Teay River to seek the new course now occupied by the Kanawha, and also deposition of the laminated clays. Striated cobbles here lend support to the ice dam hypothesis in that it indicates ice action in Teay Valley at the time the Teay formation was deposited.

A more detailed description, with illustrations of the cobbles, will be published elsewhere.

JULIAN J. PETTY

UNIVERSITY OF SOUTH CAROLINA

THE NATIVITY OF THE PUMPKINS

VARIOUS opinions have been expressed as to the nativity of *C. pepo* and *C. moschata*, our cultivated pumpkins. Some botanists regard them as of American origin and others as native to eastern Asia.

Since the plant has never been found in its natural habitat the subject has been one of speculation based upon certain terms of inexact meaning. Recently, however, there has come to light through the activities of the archeologists a rich store of material which throws important light on this subject. In the recoveries from the Cliff Dweller ruins fragments of the rind and peduncle in an excellent state of preservation have been secured and in the mortuary bowls seeds of cucurbits are found, the taxonomic characters of which are clearly defined. This material is now in the Peabody Museum of Harvard University and was collected by Messrs. Kidder and Guernsey. Also, in the Colorado State Historical Museum, are found specimens recovered by Dr. Paul S. Martin. The writer has been privileged to study these collections and finds numerous specimens of *C. moschata* and *C. pepo*. In the instance of the Peabody collection, some of the specimens are quite ancient. According to Kidder they are from the Basket Makers, a culture antedating the Cliff Dwellers, and are regarded by him as belonging to the period 1500 to 2000 B. C.

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[1] C. K. Wentworth, "Striated Cobbles in Southern States," *Bull. Geol. Soc. Am.*, 39: 941–954, 1928.

[2] *Op. cit.*, p. 948.

[3] M. R. Campbell, SCIENCE, n.s., 12: 98–99, 1901.

Interesting material of a similar character has come to light in the explorations made by Mr. Neil M. Judd under the direction of the National Geographic Society at Pueblo Bonito, New Mexico. In this material fragments of stems and seeds are found which are identified by Dr. C. V. Coville as *C. pepo* and *C. moschata*.

From the Everglades of Florida Dr. John K. Small has collected a plant of unknown origin which is running wild and is known as the Seminole Indian pumpkin, a variety of *C. moschata*.

In the Guadalupe Valley of southern Texas occurs a cucurbit closely related to *C. pepo* which appears to be indigenous. L. H. Bailey collected specimens in its natural habitat which he identifies as *C. texana*.

The fact that *C. pepo* and *C. moschata* are indigenous to North America seems clearly established. The nativity of the third species, *C. maxima*, the squashes, is still in the dark, and we are in hopes that the archeologists may in time be able to throw light upon this subject also.

A. T. Erwin

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STARLINGS IN OKLAHOMA

That the starling this winter invaded the state of Oklahoma may be of interest to some ornithologists and zoologists. The starlings have not been reported before this year for this state, but appeared in considerable numbers in Tulsa County in December, 1929, as reported by Miss Edith Force, of the Tulsa city schools. The birds appeared on the campus of the University of Tulsa at different times during the three weeks of cold weather beginning January 10. During this period, there was a snowfall of about twenty inches, and the thermometer reached the zero mark at different times. On the night of January 13, amidst a storm of snow and sleet, a starling flew through an open window of one of the dormitories where it was caught and identified the next morning. Dr. R. D. Bird, of the department of zoology, Oklahoma University, says that starlings appeared on the state university grounds and in the vicinity of Norman, Oklahoma, at the same time they were seen at Tulsa in January. The starlings left the above-mentioned communities when the cold weather broke up, during the first week in February, and so far as the writer knows, no one has observed them in this locality since.

H. D. Chase

University of Tulsa

SCIENTIFIC BOOKS

Operational Circuit Analysis. By Vannevar Bush, Eng.D., professor of electric power transmission, Massachusetts Institute of Technology. With an appendix by Norbert Wiener, Ph.D., assistant professor of mathematics, Massachusetts Institute of Technology. John Wiley and Sons, Inc., New York; Chapman and Hall, Ltd., London, 1929.

It is now nearly fifty years since Heaviside introduced the shorthand operational methods associated with his name for the solution of circuit problems arising in telegraph and telephone engineering. The adoption of these methods by engineers has been relatively slow. This has been due partly to a lack of a compact, orderly exposition of the methods and partly to a natural aversion to the intellectual labor of mastering a novel discipline which appeared to offer a less rigorous alternative to classical methods which had to be mastered in any case as a preliminary to the understanding of the new tools. Those who were only occasionally faced with such problems could scarcely be expected to make an attempt at such a mastery.

The great expansion of the field of communication engineering in the last twenty-five years and the applicability of its results to other fields (notably acoustics) have, however, forced an intensive development of the mathematical tools available, in which increasing attention has been paid to the Heaviside methods so that a considerable literature now exists. The present work is, however, the first attempt to embody the subject in text-book form.

Professor Bush is to be congratulated on the success with which he has performed his task. The superposition theorem, the integral theorem and the expansion theorem are developed in a manner to bring out clearly their interrelations and their relative contribution to the direct operational procedure. The fundamental grounding of the Heaviside methods in the Fourier analysis and their relation to the theory of functions of a complex variable are adequately treated. The style in which the book is written is simple, direct and not lacking in a wit entirely appropriate to a disciple of his master, though free from the bitterness and even malice that so often characterizes the latter's amusing outbursts.

A considerable number of interesting and suggestive problems conclude each chapter, and a valuable table of operational formulas is given as an appendix. Professor Bush's colleague, Professor Wiener, has contributed a brief but valuable appendix on Fourier analysis and asymptotic series. The bibliographical references are ample, and the text seems to be reasonably free from typographical errors.

It is to be hoped that in future editions the important subject-matter of Chapter XV, "Networks with Variable Parameters," may be treated at greater length. The problems arising under this heading are at the same time of the greatest importance and offer the most formidable difficulties. In particular, it would seem desirable to add some account of the "perturbation" methods of approximate solution, which Van der Pol has shown how to adapt from astronomical to vacuum tube circuit problems.

LYNDE P. WHEELER

NAVAL RESEARCH LABORATORY

The Economics of Forestry. By W. E. HILEY, M.A., Oxford. Clarendon Press, 1930. Price 21/–.

NEW ground has been broken by the publication on March 20 of a book on "The Economics of Forestry," by Mr. W. E. Hiley, M.A., of the School of Forestry, Oxford. Mr. Hiley is well known in forestry circles not only in Great Britain but also in America and throughout the British Empire by reason of his publications on forestry subjects, one of the most important of which is his book on "The Fungal Diseases of the Common Larch." After the publication of this work he decided to give up the mycological side of forestry, being attracted by the possibilities of the practically unknown field of forest economics, and he started a course of lectures on this subject in the Oxford Forestry School. From this has developed the matter which has been so carefully and lucidly elaborated in the pages of this book, in which the theory of forest economics is applied to the practice of forestry in a more definite manner than has hitherto been done.

Whether the object of forestry should be to obtain the best financial returns has often been questioned; other objects, such as the fixation of mountain slopes and sand dunes, the regularization of the water flow and protection from wind, must always be kept in mind by the forest officer. But apart from these aspects of the subject, the prospect of obtaining satisfactory profits is a very important incentive to private afforestation; in state forestry, also, it is desirable that for every dollar spent the greatest possible value of timber should be produced in the shortest possible time. Thus, in fact, forest economics must be the determining factor in state, as well as private, forestry.

Owing to the long period of production in forestry, calculations have to be made with compound interest, and various methods have been used for estimating profitableness. Mr. Hiley particularly favors two methods: that of determining the "financial yield," which is the rate of compound interest earned on a plantation or forest on the money invested in it; and the method of "cost of production per cubic foot" calculated by allowing some fixed rate of interest on capital. With either method the costs of all operations and the value of intermediate returns are taken into account.

He has applied these methods to all British-grown species for which data are available, and has shown that, whereas Scots pine (*Pinus sylvestris*), for instance, is very expensive to grow and can yield only a low rate of interest on capital, Douglas fir (*Pseudotsuga taxifolia*) and Sitka spruce (*Picea sitchensis*) are very cheap to grow and may yield a comparatively high rate of interest. Since Scots pine is a very easy tree to cultivate and grows on cheap land, such a result is not at first obvious; the high cost of production is due to the slow rate of growth and the long rotation.

It is also shown that timber can be grown much more cheaply on good land than bad even when high prices have to be paid for good land. Heavy thinning is generally more profitable than light thinning, and wide planting than close planting. Also small sizes of timber are so much cheaper to grow than large sizes that, as virgin timber becomes scarcer, there will be very strong inducements towards the use of laminated wood and other artificial forms of large timber.

Thus far the book follows the course which we should expect the study of forest economics to follow in Britain, where reafforestation is the order of the day and a large amount of capital is being invested in making future forests. But in America, too, now that more and more attention is being paid to the reafforestation of denuded lands, it is becoming imperative that the relative economic attractiveness of various tree species and methods of management should be studied in detail. For the particular conditions covered by Hanzlik's data the author has calculated the most favorable rotation for growing Oregon pine ("Douglas fir") in the western states.

Where forests have not yet been destroyed the author shows it is possible to put them under a form of management by which they will yield a continuous supply of timber. Where the existing stand is sufficiently valuable this form of development may be secured without investing fresh capital. It does, however, require restraint in the exploitation of the existing forests, and the economics of this type of development is rather different from that of afforestation. In the last chapter, which is entitled "The Economics of Sustained Yield," the comparative economics of devastation and conservative forest management is discussed, with special reference to America, and tendencies are traced towards a more constructive view of company management being adopted.

The profitableness of forestry will be greatly affected by any change in prices. Questions of timber resources and consumption are dealt with, both as regards Europe and America, and price movements are traced for nearly ninety years. These prices have been corrected for changes in the purchasing power of money, so that movements in real prices may be observed. It is interesting to note that, although the real price of sawn softwoods imported in Britain rose rapidly from 1871 to 1900, there was a subsequent fall lasting till the great war and present real prices are little, if any, higher than in 1900.

J. Burtt Davy

Imperial Forestry Institute,
Oxford University,
March 25, 1930

SCIENTIFIC APPARATUS AND LABORATORY METHODS

FRUIT AND VEGETABLE PIGMENTS AS INDICATORS

A few years ago a study was made of the coloring matter of certain European grapes by Willstätter and Zollinger,[1] and of several American varieties by Anderson and Nabenhauer.[2, 3] All the pigments were found to be chemically similar, being composed of the monoglucoside oenin in the case of the European grapes, and in the case of the American of anthocyanin, which is similar to oenin but with a smaller percentage of methoxyl. It was noted that solutions of some derivatives of anthocyanin turned bright red when acidified and blue or bluish-green when made alkaline, the pigment decomposing in a short time if left in alkaline solution. It does not appear that these workers investigated the indicator values of grape pigments, and Clark does not list any of the products of grapes or of grape skins among the indicators he describes in his book on hydrogen ions.[4] Industrially, however, advantage is taken of the color changes of grape pigments by wine manufacturers, "since red wine is very commonly titrated for total acidity, using the color change from red to green as an endpoint."[5]

After noting the color change in grape-juice while working on a problem in dietetics and recalling that Clark's list of indicators includes the extract of red cabbage,[4] it occurred to us that the pigments of other fruits and vegetables might exhibit similar characteristics. We accordingly began to study such varieties as were readily obtainable, testing for the presence of pigments showing a color change, for the pH range of such color changes as were observed and for the practical value of the pigments for use where liquid indicators or test papers might be needed.

Apricots, carrots, peaches, pears, persimmons and tomatoes failed to yield pigments with indicator characteristics. The pigment of red beets remained red throughout the acid range and into the alkaline range at least as far as pH 13.0. On the other hand, red apples, blackberries, blueberries, prickly pear cactus fruit, black cherries, cranberries, dewberries, grapes of all colors from red to black, loganberries, Satsuma plums, pomegranates, black and red raspberries and strawberries proved to contain pigments of more or less indicator value.

In all cases we at first made decoctions of the fruits or vegetables. Of grapes and apples we used only the skins. The test material was simmered for about fifteen minutes in as little water as practicable, then the colored solution was separated from the pulp by straining through several layers of cheesecloth. We found later that with blackberries, cactus fruit, black cherries, dewberries, pomegranates, raspberries and strawberries a better solution could be obtained by crushing the raw fruit and pressing out the juice. To clear and preserve the solutions we added half their volume of 95 per cent. alcohol, let them stand for several hours and then filtered them.

A series of standard buffers was used in testing the pH range covered by the color changes. The following table shows what we found in the case of ten pigments.

The pigments from all colors of grapes were found to be similar as to indicator characteristics, the only difference being that the darker the color of the grapes the more concentrated the solution of pigment obtainable from their skins. The same is true of the class of fruits consisting of blackberries, dewberries, loganberries and raspberries. We have not had time to purify these fruit pigments and study their chemical composition, but from the colors they show and the pH range they cover we judge that most of them are derivatives of anthocyanin or similar compounds.

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[1] R. Willstätter and E. H. Zollinger, *Ann. Chem.*, 408: 83, 1915; 412: 195, 1916.

[2] R. J. Anderson, *J. Biol. Chem.*, 57: 795, 1923; 61: 685, 1924.

[3] R. J. Anderson and F. P. Nabenhauer, *J. Biol. Chem.*, 61: 97, 1924.

[4] W. M. Clark, "Determination of Hydrogen Ions," pp. 84–98, 1923.

[5] S. R. Benedict, personal communication.

Fruit source	Color change	pH range
Apples	Red to yellowish-green	6.2– 7.2
Blackberries	Red to dark grayish-blue	6.0– 7.4
Blueberries	Reddish-purple to greenish-purple	6.2– 7.2
Cactus	Red to faint purple	9.0–12.0
Cactus	Faint purple to reddish-brown	12.0–13.0
Cherries	Red to bluish-purple	6.0– 7.2
Cranberries	Red to yellowish-green	6.2– 7.2
Grapes	Red to purple	5.0– 6.6
Grapes	Purple to green	6.6– 7.6
Plums	Red to yellowish-green	6.2– 7.2
Pomegranates	Red to purple	6.0– 6.8
Pomegranates	Purple to green	6.8– 7.6
Strawberries	Red to yellowish-green	6.2– 7.2

Any of the pigment solutions, except that of cactus fruit, can be used in the titration of acids. As kept in the form of alcohol preserved solutions, they have stood for several months without showing any signs of deterioration. They can not be used in titrating bases, for in a solution which is no more than moderately alkaline they soon decompose, all of them producing a brown color which does not change when acid is added. The faint purple and reddish-brown colors of the cactus pigment are comparatively resistant to alkalis, but the pH range of the color change is too far over on the alkaline side to make the pigment of much use in titration work. Since, however, it is not poisonous, has but little odor or taste and holds its deep red shade over so wide a pH range, one can easily see why certain housewives in parts of the United States where prickly pear cactus grows have found it so satisfactory a coloring agent in jelly-making.

The most practical use that we have found for these indicators is in making test papers. Soaking a cheap grade of thin filter-paper in the crude decoctions—it is not necessary to clear with alcohol for this purpose—and then drying the paper, gives a satisfactory neutral-tinted product in most cases. The natural acid of apples, cranberries, plums and pomegranates is sufficient to cause the production of red papers. When such papers are dry it is best to wet them with .2 per cent. ammonium hydroxide, rinse quickly and dry again. This treatment changes the color to a neutral tint. The fact that these fruit pigment test papers have a definite neutral tint, as well as an acid tint and an alkaline tint, is an advantage. Their color changes, however, are in some cases a bit different from those of the corresponding pigment solutions. For this reason we add a brief table to show what may be expected of the papers.

Fruit source	Neutral tint	Acid tint	Alkaline tint
Apples	Grayish-purple	Red	Green
Blackberries	Purple	Red	Bluish-green
Blueberries	Purple	Red	Blue
Cherries	Reddish-purple	Red	Bluish-green
Cranberries	Faint purple	Red	Light green
Grapes	Purple	Red	Bluish-green
Plums	Faint purple	Red	Light green
Pomegranates	Purple	Red	Bluish-green
Strawberries	Reddish-purple	Red	Light green

Summary

(1) Solutions of many fruit pigments act as indicators.

(2) These solutions are easily prepared and stable, and the pH range of their color changes is in most cases conveniently near the neutral point.

(3) As liquid indicators they can be used in titrating acids, but not bases.

(4) Their greatest usefulness depends upon the fact that very satisfactory test papers can be made with them in a simple and inexpensive way.

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THE SPOTTING METHOD OF WEED ERADICATION

In the eradication of ragwort, reported by Grimmett,[1] mention is made of placing about an ounce of dry mixture of equal parts of finely crystallized sulphate of iron and sodium chloride on the crown of the individual plants. A later examination of the area so treated showed 100 per cent. killing. The plants were rotted and could be pulled out easily. In no case did regrowth occur from the roots. In most cases a ring of grass from a few inches to a foot in diameter was also killed.

Some years ago the writer, while considering methods of eradicating plantain and dandelion in a young blue grass lawn, conceived the idea of using a fertilizer instead of a toxic salt to plasmolyze the weeds. By so doing the surrounding grass would be stimulated after the weed was killed and after the fertilizer had been washed away sufficiently from the point of application to reduce it to a concentration that is non-plasmolytic.

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[1] B. E. R. Grimmett, "Chemical Eradication of Ragwort," *N. Z. Jour. of Agr.*, 34, 4: 256.

Each spring, for several years, this spotting procedure has been practiced. As much sulphate of ammonia as can be held between the fingers and thumb is placed on the crown of the weeds. As Grimmett reported, weeds so treated die quickly and completely. The grass surrounding the weed dies also, but in no case is the circle of dead grass so large as one foot across, as Grimmett reported sometimes occurs from the use of the toxic salt. Shortly the growth of the grass bordering the circle is tremendously accelerated so that within a few weeks the whole bare spot is covered with a thrifty growth of grass.

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SPECIAL ARTICLES

CAPACITY OF CONDENSERS IN SERIES

The object of the present note is to show that the conventional formulation for the total capacity of electrical condensers joined in series or cascade is unnecessarily inexact. The formulation referred to is: The reciprocal of the total capacity of any number of condensers connected in series equals the sum of the reciprocals of the discrete capacities of all the individual condensers. The cause of the inexactness of the formulation lies in the fallacious idea which is brought out typically in the following quotation from a generally excellent book: "Since the outflow from one condenser constitutes the charge on the next, the charge *Q* on the positive coating of each must be the same and equal to that communicated to the first condenser." This premise was found by me to be involved, either explicitly or implicitly, in all the relevant books, save one, which were accessible in two libraries. By no means are all these books elementary texts; on the contrary, the names of several of the most noted living Dutch, English and Russian physicists are to be found on the respective title-pages. The exceptional book is by E. Mascart and J. Joubert (tr. by E. Atkinson), entitled "A Treatise on Electricity and Magnetism." A qualitative hint at the correct state of electrical distribution is given on page 72 of the first of the two volumes.

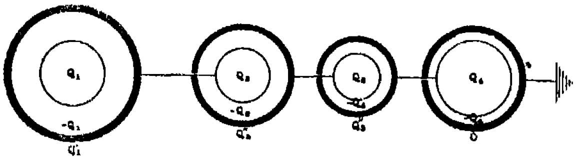

Fig. 1

It will be sufficiently general for the purposes of this note to outline the proof of the rigorous formula for the case of four spherical condensers connected by ideal wires of infinite length and zero capacity, as suggested by the accompanying diagram. The radii of the central sphere, of the inner surface of the concentric shell and of the outer surface of the shell will be denoted respectively by r_i, r_i' and r_i'', for the i th condenser ($i = 1, 2, 3, 4$). The corresponding charges on these three surfaces are Q_i, Q_i' and Q_i''. $1/C_i = \kappa(1/r_i - 1/r_i')$ and $C_i'' = r_i''$. The charge Q_1 is at the potential V_1 and the outside of the fourth condenser is "earthed." Then the following conditions must be fulfilled:

$$
\begin{aligned}
V_1 = Q_1/C = Q_1/C_1 &+ Q_1''/C_1'' \\
-Q_1 + Q_1'' + Q_2 &= 0 \\
-Q_2 + Q_2'' + Q_3 &= 0 \\
-Q_3 + Q_3'' + Q_4 &= 0 \\
Q_1''/C_1'' &= Q_2/C_2 + Q_2''/C_2'' \\
Q_2''/C_2'' &= Q_3/C_3 + Q_3''/C_3'' \\
Q_3''/C_3'' &= Q_4/C_4
\end{aligned}
$$

Elimination of all the Q's from the preceding equations leads to the following general type of continued fraction:

$$
\frac{1}{C} = \frac{1}{C_1} + \cfrac{1}{C_1'' + \cfrac{1}{\cfrac{1}{C_2} + \cfrac{1}{C_2'' + \cfrac{1}{\cfrac{1}{C_3} + \cfrac{1}{C_3'' + C_4}}}}} \qquad (1)
$$

The way in which the various capacities are involved in formula (1) is instructive and interesting. Formula (1) can not reduce rigorously to the conventional equation

$$
1/C = 1/C_1 + 1/C_2 + 1/C_3 + 1/C_4 \qquad (2)
$$

unless $C_i'' = 0$, and this is impossible since the outside radii of spherical condensers can not vanish. Incidentally

$$
Q_4 = Q_1 - (Q_1'' + Q_2'' + Q_3'')
$$

so that Q_4 can not equal Q_1, since the parenthetical trinomial is always finite.

Although the goal of this note has been reached already in the above theoretical deductions, it seems desirable to give some numerical data in order to show the order of magnitude of the charges and errors.

Let all the condensers be identical with $r_i = 10.00$

cm, $r_1' = 10.20$ cm, $r_1'' = 10.25$ cm and hence $C_1'' = 10.25$ e.s.u. and $C_1 = 510$ e.s.u.

Case 1. $\kappa = 1$. Then $100 Q_4/Q_1 = 89.08^0/_0$, $100\ Q_3''/Q_1 = 1.79^0/_0$, $100\ Q_3/Q_1 = 90.87^0/_0$, $100\ Q_2''/Q_1 = 3.62^0/_0$, $100\ Q_2/Q_1 = 94.48^0/_0$, $100\ Q_1''/Q_1 = 5.52^0/_0$. Formulas (1) and (2) give $C = 136.207$ and $C = 127.5$ respectively, hence the error of equation (2) is about $-6.4^0/_0$ in this special case.

Case 2. $\kappa = 80/17 = 4.706$ (paraffin oil). $C_1 = 2400$ e.s.u. $100\ Q_4/Q_1 = 97.49^0/_0$, $100\ Q_3''/Q_1 = 0.42^0/_0$, $100\ Q_3/Q_1 = 97.91^0/_0$, $100\ Q_2''/Q_1 = 0.83^0/_0$, $100\ Q_2/Q_1 = 98.74^0/_0$, $100\ Q_1''/Q_1 = 1.26^0/_0$. Formulas (1) and (2) give $C = 608.915$ and $C = 600$ respectively, hence the error of equation (2) is now about $-1.5^0/_0$.

In conclusion, attention may be called to the fact that it can be shown, by paying special attention to the definitions involved, that the general ideas presented above can be extended to the case of parallel-plate condensers.

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FURTHER OBSERVATIONS ON ADRENALECTOMIZED CATS TREATED WITH AN AQUEOUS EXTRACT OF THE SUPRARENAL CORTEX

IN a brief communication which appeared in this journal a few weeks ago (SCIENCE, 71: 321–322, 1930) the writers described the preparation of an active extract of the suprarenal cortex which maintains bilaterally adrenalectomized cats in normal condition. At the time of publication our oldest experimental animals had been under observation eighty days. Several of our treated cats recently reached their one-hundredth day of survival and were in excellent condition at that time. They all showed steady weight increases and could not be distinguished by their behavior from unoperated control animals.

At present we have no idea how long cats so treated will survive, since none of the animals receiving extract has presented symptoms, and so far as we know to the contrary they would survive indefinitely. However, when the animals reach the hundredth day of survival administration of extract is discontinued, and in every case tested death from adrenal insufficiency results within ten days. The onset of symptoms is abrupt, more so than in adrenalectomized cats not receiving treatment. Autopsy reveals the same findings as observed in untreated animals dying of adrenal insufficiency. The fact that the long surviving cats invariably die with typical adrenal insufficiency symptoms following cessation of treatment demonstrates conclusively that it is the extract which keeps them alive and in good health, and that no question of accessory cortical tissue is involved. We have used chiefly male cats in our survival experiments.

The following table shows the weight changes in a typical experimental cat. The striking weight loss which follows withdrawal of treatment is characteristic of all our animals.

TABLE I

No. 1 MALE				
Dec.	16	3160	grams.	R. adrenal removed.
Dec.	24	3185	"	L. adrenal removed. Treatment started Dec. 25.
Jan.	28	3320	"	
Feb.	12	3300	"	
March	5	3420	"	
March	12	3500	"	
March	22	3765	"	
March	30	3820	"	
April	3	3835	"	Extract discontinued. Animal in perfect health.
April	7	3630	"	
April	8	3610	"	Symptoms of suprarenal insufficiency.
April	9	3515	"	Symptoms of suprarenal insufficiency.
April	10	3400	"	Marked symptoms.
April	11	3355	"	Prostration, death.

Recently we have completed a series of experiments in which the adrenalectomized animals were not treated until adrenal insufficiency symptoms had developed, such as total anorexia, weight losses of several hundred grams and weakness in limbs so that the animal swayed unsteadily when walking. By injecting subcutaneously 2 cc of cortical extract three times daily, we have been able to bring such cats back to normal health, with complete disappearance of all symptoms of adrenal insufficiency. Following return to normal the animals are then given the regular treatment of 0.5–1 cc of extract per kilogram of body weight daily. This is an arbitrary dose since the minimum dosage has not been determined. We have several such animals in the laboratory which have returned to normal and are now in their fiftieth day of survival.

It is interesting to note that the disappearance of adrenal insufficiency symptoms is a fairly slow process and requires from four to five days of treatment. The maximum quantity of fluid given in twenty-four hours to any one cat showing symptoms is six cubic centimeters. This amount can be cut in half by further concentration of the extract and the results are the same.

It has been found that the fractions containing the cortical hormone can be conveniently and safely stored in benzene or alcoholic solution. The writers prefer to use the term *cortical hormone* pending definite knowledge of the chemical nature and physiological function of the hormone or hormones involved. Further fractionation experiments are in progress.

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CERTAIN BIOLOGICAL EFFECTS OF HIGH FREQUENCY FIELDS

Biological utilization of the electromagnetic spectrum has only recently spread into the region between radio and infra-red rays, with promise of revealing a useful field. The material and methods used in the present study have some advantages in outlining the problems to be taken up in a subsequent detailed analysis of the biological effects of this physical force.

A preliminary survey of the individual variation in response of *Habrobracon juglandis*, a parasitic wasp, to the same dosage in a high frequency electrostatic field is here reported. Exposure was made at 3.5 meter wave-length and auxiliary circuit current of 1.8 amperes.

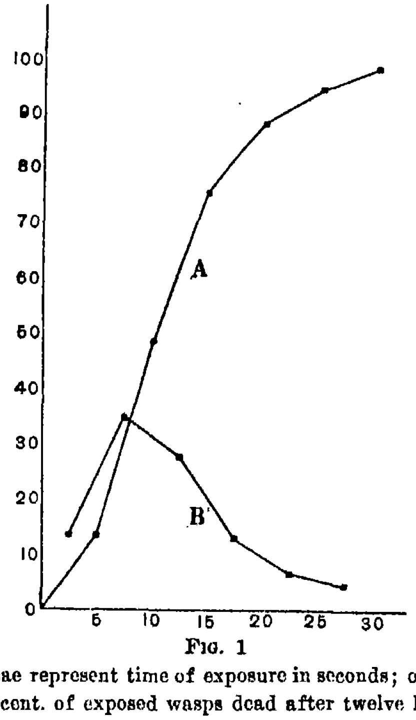

Fig. 1

Abscissae represent time of exposure in seconds; ordinates, per cent. of exposed wasps dead after twelve hours.

Material, nearly random as to age, sex, condition of feeding and metabolic state, as determined by temperature at which wasps have been kept, was used. Wasps placed together in the field for the same length of time may be apparently lifeless, normal or in any intermediate condition at the end of the exposure.

Effects of the field were measured by lethality, which can not be determined immediately, since apparently lifeless individuals may recover, and normals die, within the first few hours after treatment. Groups of ten to fifteen were exposed together, and counts of living and dead were made twelve hours later when individuals could be assigned definitely to either group.

Curve A shows totals of such counts, expressed as percentage of total exposed which were dead after twelve hours, treatments being for five, ten, fifteen, twenty, twenty-five and thirty seconds. Curve B shows the increase in lethal percentage at each dosage over that of the next smaller exposure; it expresses the percentage of individuals expected to die within ± 2.5 seconds of each exposure time. The average time for death was 11.41 ± .09 seconds of treatment. The coefficient of variability was 56.27 ± .74 per cent., determined from 2,159 wasps.

An attempt is being made to determine any possible part age, sex, feeding and metabolic state may play in the wide range of individual susceptibility to the high frequency field, first observed by others in mice, by testing the range of variability under the action of each factor separately, the other three being kept constant.

G. Murray McKinley
Donald R. Charles

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University of Pittsburgh

BOOKS RECEIVED

Caldwell, Frank C. *Modern Lighting.* Pp. xi + 386. 127 figures, 22 tables. Macmillan. $4.25.

Edwards, Junius D., Francis C. Frary and Zay Jeffries. *The Aluminum Industry.* Volume I, *Aluminum and its Production.* Pp. xii + 358. 63 figures. 6 tables. Volume II, *Aluminum Products and their Fabrication.* Pp. xviii + 870. 344 figures. 129 tables. McGraw-Hill. $12.00.

Gates, Arthur I. *Psychology for Students of Education.* Revised edition. Pp. xv + 612. 50 figures. Macmillan. $2.25.

Kenly, Julie C. *Green Magic:* The Story of the World of Plants. Pp. xii + 184. 63 illustrations. Appleton. $2.50.

Mott-Smith, May. *Africa From Port to Port.* Pp. xiv + 424. 66 figures. Van Nostrand. $4.00.

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THE REPUTED CONFLICT BETWEEN THE LABORATORIES AND CLINICAL MEDICINE[1]

By the late Dr. C. F. HOOVER

WITHIN the past few years the idea has frequently been expressed that there is a conflict between the "laboratories" and the practice of medicine. Just how this impression has gained currency is difficult to express in a few words because any particular conflict may start from so many different causes and may come from either side. We should not wonder at this conflict, because it is only in the past thirty-five years that the laboratory has shared much in clinical diagnosis. Formerly chemistry and microscopy contributed only to post-mortem studies, and instruments of precision that can be used in clinical studies are very new. Like the art of medicine, the merits of laboratory devices depend on a directing intelligence, and no kind of contention is inspired by such a warm spring of egotism as the defense of one's intellectual self-esteem. Until very modern times, laboratory work was the avocation of practitioners, but now the laboratory methods have grown so much in importance and in variety that their employment has attained the dignity of a vocation. Naturally want of knowledge, prejudice and professional vanity may lead one side to belittle the other's importance. Nothing so readily stirs the vanity of a member of any of the learned professions as an attempt to dim the light of which he is conscious. So we have not far to seek for the reason why we should occasionally meet with champions of contending views who resent either the tyranny or obstinacy of their opponents.

Every honest practitioner of medicine welcomes all aids to diagnosis and will employ all devices that furnish knowledge or supplement his diagnostic needs. Nor should he resent the substitution of an instrument of precision for his art if the instrument is more dependable. Such a mental attitude savors of the trade union and is unworthy of a learned profession.

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[1] This paper was read by Dr. Hoover before the Cleveland Academy of Medicine. It is presented for publication by his wife, Katherine Fraser Hoover.

A serious and estimable complaint has come from practitioners who do not decline laboratory contributions but do object to the complaisant submissiveness with which practitioners yield to tests and instruments of precision and thus seek to escape their professional obligations. This tendency is perceptible not only in private practice but also in teaching hospitals where the art of medicine may be poorly cultivated and voluminous laboratory reports are exhibited as evidence of profound clinical study.

Proficiency in the art of diagnosis is gained only at the expense of patient toil and much time. An unskilled craftsman gladly takes shelter under the pretensions of precise devices that hide his poverty of resources. By this statement it is not intended to scoff at instruments of precision or to discourage the mastery of their employment. What is disapproved is submission to these devices without control by clinical logic. Instrumental devices always give truthful results, but he who employs them must know if the premises are true, and only a critical clinician can tell if the instrument is employed under the conditions that supposedly are present. A simple instance of this kind is the use of the sphygmomanometer. We compress the brachial artery by pneumatic pressure that is measured by a mercury column. What could be simpler or apparently more dependable than those factors of air pressure and the weight of a measured column of mercury? Not many years ago an eminent surgeon who was discussing the modern progress of medicine said, "Now that we measure blood pressure, what has become of the tactus eruditus that was the boast of skilful physicians in former years?" By way of retort the same question may be asked in refutation of his argument, for without control by the tactus eruditus the blood-pressure instrument is a very undependable device. I have heard very good clinicians say that palpation of the pulse is no longer of service since we can measure the maximum and minimum arterial pressure. It should rather be said that since we pretend to measure blood-pressure it is more needful that we should cultivate the art of arterial palpation to avoid the pitfalls of the instrument. And so the same argument can be amplified by saying that supposed precision of all laboratory information demands a more diligent cultivation of the bedside art to escape the tricks these devices play us. On the other hand, nothing will more enlarge, adorn and enrich the clinician's point of view than to employ laboratory devices in the solution of clinical problems.

To flourish and develop the clinician needs rich and various sources to feed his mind. No man is creative enough to invent his own requirements in sufficient quantity. For this reason no man can afford to live on his own ideas. All must shrivel who live within their own world, no matter how large it may be. The zest for curiosity that exceeds the bounds of one's own activity must be cultivated or ossification will follow. By such a statement it is not meant that all clinicians to grow must work in laboratories, for there are men who throw themselves into the midst of busy practice, gather new knowledge and grow wise in medical philosophy without entering a laboratory or mastering its methods. But there is a great difference between retaining contact with practice and becoming its victim. If in the midst of practice one spends all his time in devising methods for his patients' comfort, or what is still more likely, if he becomes the victim of practice and spends his time in tittle-tattle and serves the prejudices of his patients rather than educates them, he will in a few years dry up the sources of mental life and lose all creative desire.

There is one kind of clinician who has become submissive in the presence of laboratory reports. He resigns his art in the face of instrumental devices and does not employ the information gained from both sources. For reciprocal criticism, each point of view should rein the other to obtain the best results. I am quite sure that I have been criticized as old-fashioned and reactionary, not because I have failed to welcome information from laboratory sources, but by reason of the fact that I have always urged medical students to retain a grasp on the art of diagnosis and never submissively to accept a laboratory report without submitting it to strict clinical criticism. The kind of practice I have disparaged is to measure blood-pressure without previously analyzing the character of a pulse and estimating the pressure with the fingers, or to have an X-ray picture made of the thorax and then examine the patient. If one examines a thorax after the X-ray picture is seen, he is very prone to make his examination conform to the interpretation of the Roentgenogram. Or with a patient complaining of symptoms that are not readily explained to make a Wassermann test and on this test alone accept or reject a diagnosis of syphilis. Or in the presence of fever and suspicious cardiac symptoms, to base the presence or absence of endocarditis on the results of bacteriological blood cultures or an agglutination test. Such practices are fatal to the cultivation of a refined clinical art. Such methods lower the art and dignity of a diagnostician to that of a conductor of tests. It reminds one much of the methods employed in the ecclesiastical courts of a few centuries past, where tests instead of evidence were employed to determine if the accused were guilty of witchcraft.

We should be wary of all tests that can not be incorporated in the sum of evidence. A test is not evidence but a touch-piece that becomes a standard or criterion for discovering the nature of disease. Such devices are welcomed because they relieve the need of mental effort. What are we to do when tests and collected evidence conflict? Obviously the thinker will abide by the evidence and the tester by his fetish.

The same complaint about the very modern tendency of clinical men to depend too exclusively on laboratory data is heard from laboratory men as well as from reproving senior members of the clinical side. Roentgenologists say that patients are referred to them with the general request to search with the X-ray for evidence of disease. And those who conduct microscopic and chemical laboratories complain of a want of clinical information for guidance in their work.

Microscopic, chemical and bacteriological endeavors that have no burning clinical needs or clinical concepts behind them are likely to be made with the spirit of factory standardization rather than with intelligent investigation. There are, of course, certain standardized laboratory tests that can be done satisfactorily by trained technicians and should be done by them, for they are not worthy of the time of a more broadly trained professional; but to centralize all laboratory work with the idea that better and unprejudiced skill is employed in such work is an error. To be prejudiced means that judgment precedes the known facts. This must be the mental attitude in all investigations. Had Pasteur had no convictions about spontaneous generation before the facts were known, would he have become the father of the science of bacteriology? Certainly prejudice must precede discovery or there will be little heat to bestir investigation. Conviction supported by fancy and conviction guided by intelligent criticism with reverence for the truth are two contrasted statements that describe two classes in the whole mass of investigation, the one ephemeral and the other permanent.

Specialization is very apt to mean contraction of mental field, and medicine is as broad as all the collected fields of biology. It has often been argued that to compare the collective efforts of many specialists with that of one broadly trained man is like comparing a mosaic with a painted picture. The simile is unfortunate and superficial, for the mosaic is a fragmentation of a constructed picture, and to reverse the process by constructing diagnoses out of fragmental views multiplies the dangers, because each fragment is a potential source of error.

Within very recent times there has come from highly credited sources a doctrine that inasmuch as the art of diagnosis has grown out of the sum of knowledge of physics, chemistry, physiology, anatomy and pathology, therefore one who is trained in these subjects possesses the components of clinical medicine and needs only a brief exercise of this collected knowledge in the clinic to become a clinician. This is an unfortunate error, for it has led to placing immature men in posts of clinical responsibility which they can never fill with credit, not because they want intelligence but because they have not spent sufficient time under the guidance of superior clinical skill. From one university we hear the complaint that they want "professors of medicine and not guinea-pig professors." In another university I have observed a ward class spend the entire morning in listening to a recital of the failure and successes of laboratory tests and hearing nothing about the many highly instructive and illuminating physical signs that should have occupied the teacher's time and must be learned by students if they master the logic of the clinic.

Such teaching methods waste the students' time, and are about as stimulating to mental effort as counting fingers or shuffling cards.

This criticism does not carry with it a denial of the great value of many laboratory methods, but it does condemn the neglect of direct observation which is apparent in some educational centers where the laboratory studies have superseded rather than illuminated clinical methods. The advancement of the laboratory should stimulate, not inhibit, bedside acumen.

Wherever laboratory technique thrives and physical diagnosis declines there is a poor school for medical students.

The very modern fashion to exalt the laboratory and lower the efforts in clinical studies has given rise to a criticism of medical education that frankly offers to lower our educational standards by eliminating a large part of the pre-clinical laboratory work that supposedly has taken the students' interest away from the patient.

To me it seems indisputable that if a keen bedside observer engages in laboratory experiment or in the use of instruments of precision to explain or confirm his clinical conceptions, it can lead only to accuracy in physical diagnosis and sharpened bedside perspicuity.

If instruments of precision supplant physical diagnosis, there is an obvious confession of diagnostic weakness. If science dulls our wits, then we own a witless science. This has actually occurred in some schools where teaching chairs are occupied by immature clinicians whose diagnostic training has lagged behind their laboratory skill.

Instruments of Precision

The blood-pressure apparatus is one of the most useful instruments that have been devised for diagnostic aid, and it is so simple and generally so dependable that it has not only come to be regarded as indispensable but it has opened such a quick and easy way to gain important information about the pulse that the cultivation of the tactus eruditus has fallen into neglect.

There remain in the pulse many things to be learned that only the learned touch will reveal, and should the tactus eruditus be ignored, the blood-pressure apparatus will often leave us not only ignorant but misinformed. The blood-pressure instrument is sometimes misinforming when a hypertonic brachial artery offers high resistance to the compressing cuff so that the arterial pressure as measured in the arm may be 250 mm Hg and in the leg 100 mm less—obviously a gross error that can not be detected without the tactus eruditus that in some quarters is quite abandoned.

Unless the blood-pressure as measured in the arm by the instrument conforms to our estimate by touch of the femoral artery, we should not accept its readings. Usually the two methods give the same results; when they do not, judgment should be suspended until the source of the disparity is explained.

For records the instrument is absolutely necessary, but if uncontrolled by the touch it may often lead us into great error in estimating the hydraulics of blood flow.

It should be remembered that when we estimate the blood-pressure by the finger, we perceive the concrete phenomenon of bursting tension and not the more abstract factor of hydraulic pressure. Bursting tension is equal to the arterial diameter multiplied by the pressure, and therefore, the pressure remaining the same, the bursting tension varies directly as the arterial diameter. In a large artery like the femoral, in which the diameter varies little with vascular hypertonus, we have an unvarying multiplication of the pressure, which does not obscure the changes in pressure when increased and diminished. If the pressure in the radial or brachial is doubled at the same time the diameter is halved, the bursting tension is unchanged and therefore a rise in pressure escapes manual detection. This is a very simple principle in physics that was not applied until after the blood-pressure instrument was employed, so the tactus eruditus is not superseded by the instrument but has become more learned and more essential because it saves us from instrumental error.

The best service a sphygmomanometer can render a doctor is to teach him how to estimate blood-pressure with his fingers. If it has not taught him how to do this, then he is at the mercy of a witless instrument.

The sphygmograph was originally employed to detect modifications in the anacrotus and katacrotus. The results of the instrument can not be accepted unless confirmed by the touch. The instrument is now used to portray graphically what we perceive by touch, and there is no better method for educating the touch than to confirm it by the instrument. But the tactus eruditus must always be the arbiter where there is any question of interpretation. To say which is the better method is much like arguing on which hand holds the soap or which hand washes the other. Both hands are essential to obtain the best results.

One of my students when visiting a hospital in another city was critically palpating a patient's pulse when the chief told him that in that clinic they had given up trying to gain information by pulse sensation, in the face of instruments of precision, and casually observed that the ancient Chinese were the only persons who had satisfying success in interpreting the pulse with the fingers. This observation is quoted because it shows how little one may profit by the use of instruments of precision.

The electrocardiograph is one of the most refined and exquisitely working pieces of mechanism that have been devised for clinical studies. The auriculo-ventricular activation is revealed with astounding clearness, and yet it is possible in most cases to predict what the electrocardiogram will reveal if we carefully determine the relative chronicity of the auricular and ventricular beats by observing the venous and arterial pulses. There are some cases in which this time relation between activations of the auricle and ventricle can be determined only by the instrument, but the instrument should teach a careful observer so that he may learn to dispense with it. It is dangerous to employ aphorisms in the service of science, but it is approximately true that any instrument of precision is of little value that does not teach us enough to dispense with its use.

THE X-RAY DIAGNOSIS OF CARDIAC AND PULMONARY DISEASES

Any criticism from an internist on the use of the X-ray that may be interpreted as detractive would sound ungrateful. No internist who had his training prior to the Roentgenogram should fail in gratitude for its aid and for its many contributions of direct evidence in problems for whose solution we formerly depended on logical interpretation. The Roentgenogram is only a silhouette of structures quite hidden from our view, and it can not pretend to think or supply evidence for any other attributes than those which form the silhouette, and in many instances of heart and lung pathology, even the silhouette is incomplete. Like the blood-pressure instrument, the *interpretation* of the Roentgenogram requires intelligent criticism, and this criticism must be based on evidence that is gathered from a history and complete physical examination. The X-ray should greatly stimulate and aid us in the cultivation of the art of physical diagnosis and not supplant the art as too often occurs. The X-ray evidence is pictorial and therefore satisfying to the uncritical, but photographic evidence very often suppresses a desire for procurable evidence that may refute what seems to be an obvious proof.

A disallowable practice is to use the X-ray as a preliminary step in diagnosis. The physical examination should first be carefully made, and then if the evidence is incomplete, a Roentgenogram may be made, and if need be in face of it the physical examination repeated and revised. But if a physical examination is made with the Roentgenogram in view, it will so strongly prejudice our findings that little will be learned from the examination. If physical examinations are made to confirm the X-ray picture, little progress is made in the diagnostic art. I have visited university clinics where much effort was expended in analyzing X-ray pictures, as if there were no other method of gaining information, for not a word was said about the results of inspection, palpation, percussion or auscultation.

Such practices are very misleading to medical students, who like all humanity are disinclined to use much effort where an easier way seems to offer a solution. Let them have unrestricted liberality in the provision of X-ray pictures and little real effort will be employed to learn the difficult art of physical diagnosis. If the student is not taught that he should endeavor to predict what the X-ray will show, he will become the servant of an instrument and not its master.

The contour of the lateral and upper boundaries of the pericardial sac is accurately revealed by the X-ray, but the inferior border and the inferior aspect of the heart are hidden in the nest of the central tendon of the diaphragm. A clear conception of this view of the heart is essential for the formation of a clear idea about protusion of a distended pericardial sac in a ventral direction, and it is also essential to gain a clear mental picture of the size of the two ventricles and the right auricle.

Cardiac diagnosis is incomplete unless we can form very definite ideas about the size of the left and right ventricles and the right auricle. The Roentgenogram does not give us as clear evidence for estimating the relative volumes of the heart's chamber as can be gained by a careful physical examination. Nor can the X-ray give us as clear a conception of the relative disabilities of the two ventricles as a careful examination will reveal. When we have learned the size of a ventricle, we have made only partial progress toward an evaluation of the heart's disease. Slight enlargement of the left ventricle in many cases of arterial sclerosis will be overlooked if only X-ray pictures are used to estimate its size. The hypertrophy of the right ventricle will also be underestimated in many cases of mitral stenosis and disease of the pulmonary arteries.

The significance of cardiac enlargement in arterio-venous fistula can not be rightly interpreted from an X-ray silhouette.

The X-ray gives us no information on the ventricular diastolic systolic excursion, which by physical examination can be plainly shown to be increased in arterio-venous fistula and also in Graves' disease.

Whenever the third, that is, the antero-posterior dimension of the heart of pericardium, is needed or the inferior or ventral aspect of the heart or pericardial sac is in question, we must depend on physical examination. If we depend on the X-ray to detect early syphilitic disease of the arch of the aorta, the diagnosis will as a rule be made too late to render aid by specific treatment.

In the study of pulmonary disease we find the X-ray of very little aid and often misleading when we try to detect incipient tuberculosis, or to gauge the activity of disease known to be present, and also in all diseases of the thorax that lie behind the phrenic dome. The X-ray fails, of course, because this region is obscured by the shadow of the diaphragm. For this reason subphrenic abscesses, abscesses at the bases of the lungs and sacculated pleurisies must all be detected by physical examination.

These outstanding and frequently occurring problems in diagnosis are mentioned as those in which the X-ray gives no aid or may be very misleading, but there are, of course, many cases of intrathoracic disease in which the X-ray is of great service, and there are also some lesions that can not be diagnosed without its aid. The criticism is not made on the use of the X-ray but against excessive dependence on its services.

In the study of cardiovascular and renal disease, we often see voluminous laboratory reports on chemistry of the blood and urine when they belie clinical evidences that are undebatable, or confirm by a laborious and expensive process what can be learned with sound economy of labor and money by a competent physical examination. It is not pleaded that such studies have no investigative value, but that they often serve to impress the uninformed laity as a clinical diagnosis based on the accuracy of mathematics and quantitative chemical estimates that supposedly should surpass clinical judgment. And it is not only the wholly uninformed laity who are thus deceived, but often the clinician is quite contented to rest his diagnosis and prognosis on deductions made wholly from such sources.

The same criticism might be prolonged into a discussion of the disappointments of clinical microscopy and clinical bacteriology. Evidence from such sources is often final and may be all we can get on which to rest a diagnosis, but such sources of information do not justify neglect of critical physical examinations. The service of the laboratories and instruments of precision are comparatively new in medicine, and some of their revelations have been so satisfying that there has been a growing tendency to supplant diagnostic effort with the employment of tests and touch-pieces. In America our proverbial enthusiasm for efficiency, standardization, factory methods and mechanistic devices has led us to weaken our cultivation of the art of diagnosis. This is only temporary; it is a transient phase of the development of medicine in America that is more accentuated than elsewhere. It would not cause any concern if this view of medicine were found only among practitioners who employ these devices to support their drooping diagnostic skill, but it is a manner of thinking that has found its way into many educational institutions where men are prepared for medical practice. It has become apparent in the programs of many of our medical societies, where attention seems to have been withdrawn from the art of medicine and devoted too largely to the cultivation of technical devices and laboratory research that has little to do with the advancement of diagnosis or treatment. A year ago, while visiting a distinguished foreign clinician who had been engaged in visiting all the centers of medical teaching in America, I was told by him that he was greatly pleased with the effort at laboratory investigation in this country, but he said, "Everywhere I went I was presented with a great lot of evidence from the laboratory, but information or interest in the physical findings on the patient were notably wanting. It seems to me that in your enthusiasm for the pursuit of laboratory evidence you have forgotten the patient."

It is not advocated that we should lessen our endeavors in the laboratory, but that we must not slacken our efforts at the bedside. Men are imitative in their methods, so that fashions in thinking gain their vogue just as do styles of millinery. And styles of thought are slowly adopted or abandoned. Much time may be lost by an errant style of thinking that will prove very costly in the intellectual development of our profession.

In recent years the way of the laboratory has provided a speedy approach to clinical chairs because the evidence for accomplished laboratory work is exhibited to so much better advantage than evidence for clinical observations. Graphic records provide evidence that has all the advantage of the pictorial method, mathematical tables provide visual evidence for acumen and diligence, and the employment of touch-pieces provides statistics that disarm all but the very critical skeptics. These devices afford a tangible method for appraising work that admits of classifications. The candidates can be ranked in the order of their productions and the method allows an approximate estimation of industry which is certainly an estimable virtue, but the evidences for the more subtle merits, intelligence, originality and truthfulness, can not be measured and weighed. Many years ago a professor of the University of Vienna said, "The method of choosing teachers for advancement is based on the avoirdupois of their publications. So that now our faculties are classified like our artillery into one-pounders, five-pounders and ten-pounders." If this mode of thinking has taken possession of our teachers and leaders in medical thought, should we wonder that lesser lights in the profession and also the laity are being led by such computable pleadings?

In conclusion, let it be understood that I do not direct criticism against laboratory methods. I do not wish to undervalue them, or wish to see our students spend less time in laboratories. *All laboratory tests and technical instruments have been devised to explain problems or to answer inquiries that have been raised by inquiring physicians.* If the results serve to slacken our cultivation of the diagnostic art instead of to sharpen our clinical insight, then the present-day medicine is in need of a renewal of the spirit that guided some of our older clinicians who never wasted their time in laboring for things beyond their reach, but who carefully and minutely studied every perceptible evidence that lay within the ken of their senses.

I have been led to offer these criticisms on a tendency in American medicine because a common complaint from physicians is their want of laboratory facilities. Often they are heard to talk as if their professional happiness would be complete if they had at their command an ample laboratory with abundant technical service. Such complaints are due to a want of cultivation of the seeing eye and sensible fingers. The exercise of intelligent clinical observation should be to a physician the most fruitful source of intellectual satisfaction. In this kind of work he can always gather new knowledge by employing originality, and he must be original to do it. Such work is more satisfying than to repeat tests which have been devised by the originality of others. A photographer derives some pleasure from a photographic reproduction of a painted picture, but how inferior is such pleasure compared with that of the original painter. When a complaining doctor leans too heavily on laboratory support for comfort in his practice, it probably means that he has failed to strengthen the powers that lie within his grasp. When by his perspicacity a doctor makes a diagnosis of an obscure case he has a glint of the same divine fire that lit the mind of Democritus when he said, "Rather would I explain the cause of a single fact than become king of the Persians."

OBITUARY

THE SCIENTIFIC WORK OF ETIENNE S. BIELER

BEFORE me are some original papers on a variety of scientific subjects published in British, Canadian and American journals—a noteworthy contribution from the pen of a deeply mourned friend and colleague cut off in the prime of his scientific activity and production. Etienne Bieler gave early proof in the advanced mathematical classes at McGill of a singularly lucid and penetrating mind and a power of concentration which his teachers felt assured would place him in the front rank of scientific men of his time. He was marked out for a career of distinction in the field of physics, and during his final years of study in Montreal covered a consistently broader range of studies than is usual. The writer well remembers in the spring of 1915 Bieler's announcing his decision to enlist in the McGill University Company, and immediately afterwards commencing to write a difficult examination in applied mathematics, in which he took brilliant marks. Returning invalided from France in 1919, he joined the postgraduate classes with a view to proceeding to his M.Sc. degree—a part of the work being taken in electrical engineering, in order to add a certain amount of breadth to a future career in pure science.

A class problem was the source of Dr. Bieler's first published paper. At that time methods had been successfully worked out in Great Britain for detecting submarines by their disturbance of the earth's magnetic field reacting on a loop of submarine cable. The complete solution of this problem was at a later date written up and communicated to Sir William Bragg, for use of the Admiralty. It was later released for publication and published in *Proceedings* of the Royal Society.[1]

It is impossible in a short article to do more than select a few papers describing Bieler's most important contributions to science. Passing over a short paper on the "Measurement of Small Capacities" (1921), giving in abstract the results of a highly creditable thesis on the distribution of electric potential across the suspension insulators used in high voltage lines, I turn to a paper published in the *Transactions* of the Royal Society of London (1924), dealing with the scattering of α-particles by light atomic nuclei. It is now well known as a result of Sir Ernest Rutherford's investigations that an atom consists of a central nucleus carrying a positive electrical charge about which are rotating a greater or lesser number of electrons or ultimate electrical particles of negative electricity. On arriving at the Cavendish Laboratory as 1851 exhibitioner, Bieler was assigned the task of investigating the nature of the electric fields in the neighborhood of nuclei of light atoms such as aluminum and magnesium. The experiment consists in firing α-particles (positively charged helium atom) from radium into a thin screen of the metal to be investigated. The deviation of α-particles passing at various distances from the atomic nuclei may be detected by the scintillations which are produced in a zinc-sulphide screen. The experiments are exceedingly laborious, as scintillation counts can not be made otherwise than by the naked eye, which must be rested at frequent intervals to be able to detect the faint effects observed. The theoretical aspect of the subject is considered in a page published in the *Proceedings* of the Cambridge Philosophical Society (1923), and there is evidence of high and mature mathematical power on the part of the author. The final result shows that the nature of the nuclear field begins to deviate from the "inverse square law" at a distance of 10^{-13} centimeters. The scientific results

[1] October, 1921.

we have just described are often quoted in the literature of the atom as a tribute to the fundamental nature of the work.

On returning to McGill as assistant professor, Bieler continued his work along similar lines, but was greatly handicapped by the lack of a suitable supply of radium, curiously enough in the very laboratory where its essential properties were first discovered. He then turned his attention to magnetism, and in preparation for an attack on the experimental side of the subject published a critical survey of the subject in the *Journal* of the Franklin Institute (1927). In collaboration with Mr. C. T. Lane, the technique for obtaining samples of extremely pure substances was developed, and the determinations made in the McGill laboratories are now quoted as among the most reliable.

In the summer of 1927 Bieler developed, in collaboration with Mr. H. G. I. Watson, a new method for geophysical prospecting which was successfully applied in the mining districts of northern Quebec. A brief account of his work is published in the *Canadian Mining and Metallurgical Bulletin* (1928), just before the author left to take charge, under the auspices of the Australian government, of an extensive program of work planned to locate, if possible, new mineral deposits. There is no doubt but that, had Bieler lived, he would have been among the foremost world authorities in this field. An appreciation of his work in England and in Australia by his coworkers there, will, it is to be hoped, appear in another issue.

He died at Geraldton, western Australia, on July 25, 1929, after a brief illness of acute pneumonia.

I have spoken only of Bieler's scientific work. He was equally at home in writing and speaking French and English, and it has several times been my privilege to hear, among a group of friends interested in literature and music, articles from Bieler which testify to a vivid imagination, an extensive vocabulary and an inside knowledge of the works of literary men.

L. V. KING

McGILL UNIVERSITY

HENRY CHAPMAN MERCER

DR. HENRY CHAPMAN MERCER, an archeologist and ethnologist of international reputation, died at Doylestown, Pennsylvania, on Sunday, March 9. Many generous bequests of scientific interest were made in his will. The famous Mercer Museum, erected and maintained by Dr. Mercer for the Bucks County Historical Society, has been bequeathed to that society and endowed with a maintenance fund of $130,000. The Mercer Museum contains a historical collection, which is internationally famous, of some twenty thousand ethnological tools and implements of the pioneer settlers of America. Fonthill, Dr. Mercer's incomparable home, is bequeathed to the public for a museum, and the beautiful grounds surrounding it are given to the Doylestown Nature Club as an arboretum, both bequests to be maintained by an endowment fund of $100,000. Another $100,000 bequest is made in memory of his uncle, Timothy Bigelow Lawrence, to Rudolf P. Hommell, Lehigh University, who now is conducting an expedition in the Far East for the collection of utensils employed in the daily life of the inhabitants.

Dr. Mercer was never married. He was born in Doylestown, Pennsylvania, on June 24, 1856. In 1879 he was graduated from Harvard with the degree of A.B. Dr. Mercer received the honorary degree of doctor of science from Franklin and Marshall College in recognition of his archeological discoveries during his Yucatan expedition. He was granted the honorary degree of doctor of law by Lehigh University. Principal among several honors bestowed on Dr. Mercer was the award of a bronze medal by the Exposition Historico-Americano Madrid in 1892 for his "Lenape Stone."

In 1882 he was an honorary member of the United States Archeology Commission at Madrid. He became editor for anthropology in the *American Naturalist*. In 1894 he was appointed by Dr. William Pepper as curator of American and prehistoric archeology at the University of Pennsylvania and filled that position until 1897.

Dr. Mercer had contributed numerous learned papers to historical publications and published many books. Among his books are "Hill Caves of Yucatan" (1896), "Antiquity of Man in the Delaware Valley and Eastern United States" (1897) and "Ancient Carpenters' Tools" (1929).

Fonthill, which was built by Dr. Mercer in 1908 and 1909, is a unique residence entirely of concrete with beautifully groined and arched ceilings, upon the interior of which Dr. Mercer lavished his finest exhibitions of ceramic art, illustrating history and historical subjects, both ancient and modern.

Dr. Charles Conrad Abbott wrote the following ode to Dr. Mercer:

Reincarnation of the storied past,
Skyward, in majesty, thy walls arise,
In strength assuring us that they shall last;
Not crumble as the common structure dies.
Thy towers, mantled with the morning light,
Proudly acclaim the past is still alive
Where proud, grim feature, or the sorry sight,
Would have the world in soulless fashion thrive.

All honor then to him who raised the pile;
Where daydreams wander through each classic room;
Where honest speech is never brought to trial,
Nor trustful candor hear its certain doom.

Defying critics, faithfully thou wrought—
Thou master builder of a fruitful thought.

ALBERT MOYER

NEW YORK CITY

SCIENTIFIC EVENTS

THE KEW BOTANICAL GARDENS[1]

FOR the public Kew is a delightful pleasaunce, for the gardener a demonstration of achievement and a suggestion of possibilities, and for the botanist a storehouse of information and a center for research. The recently issued number of the *Bulletin of Miscellaneous Information* (Appendix I., 1930), comprises under this familiar but somewhat unattractive title a review of the work of the various departments of the Royal Gardens during 1929. In 1925 work was begun on the formation of a National Pinetum at Bedgebury, in Kent, as the nearness of London is not conducive to the growth of conifers; and in spite of the long cold winter and abnormally dry summer of 1929, good progress is reported. The abolition of the penny charge for admission to the gardens from August Bank Holiday onwards is reflected in an increase in the number of visitors of nearly 220,000 between August and December, as compared with the corresponding period in 1928. The hard winter of 1928–29 and the boisterous gales of the last two months of the year caused severe losses among shrubs and large trees, but the long hot summer gave an unusual brilliance of color to the abundant crops of fruits and berries on many of the trees, and the later incessant and heavy rains effectively cleansed trees and shrubs from soot and dirt.

The more strictly botanical activities of the Royal Botanic Gardens, Kew, have benefited by generous grants from the Empire Marketing Board, which have rendered possible visits by the scientific staff and various collectors to different parts of the empire overseas and elsewhere, resulting in valuable accessions to the gardens and herbarium, and the gain of invaluable experience to individual members of the staff. Mr. Hutchinson's botanical tour in South Africa produced a harvest of more than 3,000 species, including a large number of living succulent plants. Work of botanical exploration has also been carried out in British Guiana, Persia, Somaliland and the Solomon Islands. Considerable additions have been made to the herbarium, mainly by the incorporation of stored material. An important feature of the work is the international cooperation in research rendered possible by an extension of the system of reciprocal loans between important botanical institutions; during the year more than 9,000 specimens were borrowed and nearly 6,000 sent out on loan. Botanical work in South Africa will be greatly facilitated by an arrangement to present to the National Herbarium at Pretoria duplicates of authentic specimens in the Kew Herbarium. The report of the museums records an increasing interest taken in the economic products of plants, involving much correspondence and discussion of home and colonial products with visitors. The difficulty in answering questions as to possibilities of new crops for home or the colonies is often enhanced by the lack of discretion on the part of optimistic journalists.

SUMMER SCHOOL FOR TEACHERS OF ENGINEERING

THE Society for the Promotion of Engineering Education in conjunction with the Carnegie Institute of Technology will conduct a summer school for engineering teachers beginning on June 12 and ending on June 21. The session this summer will be devoted to engineering drawing and descriptive geometry, and will be held on the Carnegie campus.

The summer school is an enterprise growing out of the general investigation of engineering education conducted by the Society for the Promotion of Engineering Education. Its general purpose is the improvement of the teaching of engineering. Each session is devoted to the study of methods of teaching a particular subject of the engineering curriculum.

William E. Mott, director of the College of Engineering, and Harry M. McCully, professor of drawing and descriptive geometry at the Carnegie Institute of Technology, are local director and secretary, respectively, of the summer course. Thomas E. French, professor of engineering drawing, Ohio State University, will be chairman of the teaching staff.

The nine-day session will begin with an address of welcome by Mr. John L. Porter, chairman of the trustees' committee of the Carnegie Institute of Technology. The various meetings will be conducted by teachers who are recognized as leaders in their fields. Entertainment features, including a smoker given by the Engineers' Society of Western Pennsylvania, will be arranged during the session. Trips to the larger Pittsburgh industrial plants have been planned.

Professors from schools in all parts of the country and from Canada and Mexico will attend the meeting. Registration will be limited to a hundred teachers.

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[1] *Nature.*

Besides those mentioned above, the teaching staff will include the following: Franklin DeR. Furman, dean of the Stevens Institute of Technology; H. W. Harold, architect, Pittsburgh; Frederic G. Higbee, the State University of Iowa; Randolph P. Hoelscher, University of Illinois; George J. Hood, University of Kansas; Harvey H. Jordan, University of Illinois; A. E. Lofberg, Westinghouse Electric and Manufacturing Company, East Pittsburgh; Clair V. Mann, Missouri School of Mines; Henry W. Miller, University of Michigan, and author of the recent book on the famous German gun "Big Bertha"; P. J. Reich, American Bridge Company, Ambridge, Pa.; Robert L. Sackett, dean of the School of Engineering, Pennsylvania State College; Charles H. Schumann, Jr., Columbia University; William G. Smith, Northwestern University; Carl L. Svensen, Texas Technological College; William D. Turnbull, the Ohio State University; Frank M. Warner, University of Washington, and William E. Wickenden, president of the Case School of Applied Science.

The summer school is under the immediate direction of Harry P. Hammond, head of the department of civil engineering, Brooklyn Polytechnic Institute. Professor Frederic L. Bishop, of the University of Pittsburgh, is secretary of the society.

AWARD OF THE DANIEL GUGGENHEIM MEDAL FOR AERONAUTICS

The second Daniel Guggenheim gold medal for notable achievement in aeronatuics has been awarded to Dr. Ludwig Prandtl, professor at the University of Göttingen, Germany, "for pioneer and creative work in the theory of aerodynamics." Dr. Prandtl is one of the world's most eminent authorities on aerodynamics and other sciences underlying the art of aviation. He is also well known as an investigator and teacher of the laws of mechanics, thermodynamics and the flow of fluids, particularly air and other gases.

Last fall, Dr. Prandtl traveled eastward from his home city as a delegate to the World Engineering Congress in Japan at the end of October and the beginning of November. He presented an important paper at this congress. After the congress, he crossed the Pacific Ocean to the United States. He stopped at a number of our universities on his homeward journey, beginning with Stanford University and the University of California. He returned home in March, completing the trip around the world.

Dr. Prandtl visited New York in February and on that occasion was entertained at dinner at The Engineers' Club by a group of forty American engineers. Following the dinner he delivered an address before the Metropolitan Section of The American Society of Mechanical Engineers. Dean George B. Pegram, of Columbia University, presided at the dinner. Dr. Elmer A. Sperry, past-president of The American Society of Mechanical Engineers and vice-president of the Daniel Guggenheim Medal Board, introduced Professor Prandtl on the occasion of his address.

Dr. Prandtl was born on February 4, 1875, at Freising, Germany, and attended the technical high school in Munich. He has been professor at the University of Göttingen since 1904. He has received many honors, among them the Great Gold Medal of the Royal Aeronautical Society of England in 1927 and the Grashof Medal of the Verein Deutscher Ingenieure in 1929. More than any other one man he stands out as the "father" of the present aerodynamic theory. He has written many treatises on subjects related to aviation and is a widely respected authority.

The members of the board which made the award are: *American*—W. F. Durand, E. P. Warner, Elmer A. Sperry, Arthur Nutt, Howard E. Coffin, Paul G. Zimmermann, E. E. Aldrin, Emory S. Land; *Foreign*—Griffith Brewer, England; Johann Schuette, Germany; Giulio Costanzi, Italy; Baron Chuzaburo Shiba, Japan. Dr. Rateau, of the Société Française de Navigation Aerienne, died before the ballot was cast.

The first award of the Guggenheim Medal for notable achievement in aeronautics was made to Orville Wright a year ago and the medal was presented to him in Washington on April 8 in connection with the celebration of the fiftieth anniversary of The American Society of Mechanical Engineers. This society is one of the two American organizations from which members of the Medal Corporation are chosen, the other being the Society of Automotive Engineers. In addition, five foreign organizations are represented on the board of award, one each in England, France, Germany, Italy and Japan.

The medal was founded in 1927 by the Daniel Guggenheim Fund for the Promotion of Aeronautics, of which Mr. Harry F. Guggenheim, now ambassador to Cuba, was then president. At the annual meeting on May 7 the following officers were elected: ***President***, William B. Stout, representing the Society of Automotive engineers, president of the Stout Air Service; *Vice-President*, Captain E. E. Aldrin, manager, Aviation Department of the Standard Oil Development Company; *Secretary* and *Treasurer*, Alfred D. Flinn, director of the Engineering Foundation; ***Executive Committee***, the president, Captain Aldrin and Mr. E. P. Warner, editor of ***Aviation***.

A. D. F.

THE RETIREMENT OF THE PRESIDENT OF THE UNIVERSITY OF CALIFORNIA

President William Wallace Campbell, who, on commencement day nearly one year ago, announced that he purposed to retire from the active service of the University of California 14 months later, on July 1, 1930, will resume his residence on Mount Hamilton, following his retirement from the presidency of the university three months hence.

William H. Crocker, chairman of the board of regents, by the authority of the regents, recently extended to President Campbell the invitation of the board that he continue to serve as director of Lick Observatory and as an astronomer in Lick Observatory from and after July 1, 1930, and until, two years hence, he should attain the age of seventy years.

President Campbell was unable to accept this valued invitation to remain in active service, with responsibilities for the directing of the observatory and for the continuous pursuit of astronomical research as an active astronomer. He felt that his decision, as publicly announced in May, 1929, was a wise one; but he informed the regents through Chairman Crocker that he would be greatly pleased to continue his residence on Mount Hamilton, with principal purpose to renew his astronomical studies and to continue them so long as his physical health and mental vigor should justify.

It has been in accord with his most ardent desires that he possess the privilege of taking up again his astronomical work at the Lick Observatory, under the auspices of the University of California. The regents accordingly, and by unanimous vote, determined that following his retirement on July 1, 1930, he should bear the titles, president emeritus of the University of California, director emeritus and astronomer emeritus of the Lick Observatory.

The regents further invited President and Mrs. Campbell to occupy the residence on Mount Hamilton which was built for them in 1894, and in which they resided continuously from that date until they came to the president's house in Berkeley in 1923, and to which in the past seven years they have frequently returned for short stays. However, and largely in consequence of their period of residence in the mild climate of the Berkeley campus, they will probably not be in actual residence on Mount Hamilton during the winter months, where the storms are frequently severe.

AWARDS OF THE FRANKLIN INSTITUTE

THE medal meeting of the Franklin Institute, Philadelphia, will be held on the afternoon of May 21. On this occasion honorary membership will be conferred on Dr. Mortimer Elwyn Cooley, dean emeritus of the College of Engineering of the University of Michigan, and on Dr. Henry Leffmann, of the Franklin Institute. The Certificate of Merit will be presented to Heyman Rosenberg, of the Parker-Kalon Corporation, New York City. Medals will be presented as follows: *Longstreth Medals* to Ervin George Bailey, Fuller-Lehigh Company, Fullerton, Pennsylvania, and to Charles Weyl, assistant professor of electrical engineering, University of Pennsylvania; the *Wetherill Medals* to Charles Sumner Chrisman, West Chester, Pennsylvania, and to William Nicholson Jennings, Philadelphia, Pennsylvania; the *Levy Medal* to Dr. Floyd Karker Richtmyer, professor of physics, Cornell University; *Henderson Medals* to George Hannauer (posthumous award), represented by George Hannauer, Jr., Chestnut Hill, Massachusetts; Edgar Marvin Wilcox, Hannauer Car Retarder Company, Gibson, Indiana; the *Clark Medal* to Henry Latham Doherty, Cities Service Company, New York City; *Cresson Medals* to Norman Rothwell Gibson, The Niagara Falls Power Company, and to Irving Edwin Moultrop, The Edison Electric Illuminating Company, Boston; the *Franklin Medals and Certificates of Honorary Membership* to Dr. John Frank Stevens, former chief engineer of the Panama Canal, and to Sir William Henry Bragg, director of the Royal Institution of Great Britain. The two Franklin medalists will present papers. Dr. Stevens will speak on "A Momentous Hour at Panama" and Sir William on "The Meaning of the Crystal." A dinner in honor of the medalists will be given in the evening at the Bellevue-Stratford Hotel.

SCIENTIFIC NOTES AND NEWS

PROFESSOR EDMUND BEECHER WILSON, of Columbia University, and Professor Sir John Bretland Farmer, of the Imperial College of Science and Technology, have been elected honorary fellows of the Royal Microscopical Society, London.

DR. L. O. HOWARD, on the nomination of the Entomological Society of Washington, has been elected an honorary member of the Washington Academy of Sciences. This action was taken in recognition of his distinguished contributions to entomology, his intimate connection with scientists and scientific work in Washington and his services to the academy as member and officer since its foundation.

THE Trudeau Medal for meritorious service will be awarded to Dr. Henry Sewall, of Denver, according to an announcement made at the opening meeting at Memphis, Tennessee, of the convention of the National Tuberculosis Association.

The Gary Medal awarded by the American Iron and Steel Institute was presented to Mr. Charles M. Schwab for his services to the iron and steel industry at a dinner given in New York City on May 9. Among the speakers announced were Dr. Michael Pupin, Dr. John Johnston, Charles W. E. Clarke, W. A. James, Dr. F. M. Becket, Charles McKnight, Lee H. Miller and Arthur D. Little.

The occasion of the eightieth birthday of Dr. David Bryson Delavan, known for his work in laryngology, was celebrated on May 3 by a dinner given in his honor by the New York Academy of Medicine at which more than a hundred members were in attendance.

The Boston Society of Natural History held its annual meeting at the museum building on May 7 when the following officers were elected: Charles H. Taylor, *president;* Nathaniel T. Kidder, Glover M. Allen and William M. Wheeler, *vice-presidents;* Clinton V. MacCoy, *secretary;* Augustus P. Loring, Jr., *treasurer,* and Thomas Barbour, Joseph A. Cushman, William L. W. Field, Laurence B. Fletcher, Frederic H. Kennard and John C. Phillips, *trustees.*

Dr. Ludwig Kast, of New York City, was elected president of the American Gastroenterological Association at the thirty-third annual meeting recently held in Atlantic City. Other officers elected are Dr. Clement R. Jones, of Pittsburgh, *first vice-president;* Dr. Burrell H. Crohn, New York, *second vice-president;* Dr. Charles J. Lucas, Louisville, *secretary,* and Dr. Thomas Wray Grayson, Pittsburgh, *treasurer.*

The prize for the best paper on scientific instruments, other than optical, to appear in *The Journal of the Optical Society of America and Review of Scientific Instruments* during 1929 has been awarded to Dr. K. C. D. Hickman, of the Eastman Kodak Company Research Laboratory, for his paper, "On Some Vacuum Recording Gauges," which appeared in April, 1929. The committee of award consisted of Professor H. W. Farwell, *chairman;* Dr. H. C. Rentschler and Professor F. W. Loomis. The committee made honorable mention of two papers by Dr. R. V. Baud, of the research department of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, on "Experimental Methods of Studying Stress Distribution" and "Further Developments in Photoelasticity," which appeared in May, 1929.

The Committee for Scientific Research of the American Medical Association has made a grant of $700 to Dr. E. Brand, research associate in chemistry, New York State Psychiatric Institute and Hospital, New York City, for further research on Cystinuria.

The J. T. Baker Chemical Company Research Fellowship in Analytical Chemistry, mid-western division, has been awarded to Mr. A. C. Shead, now at the University of Oklahoma, who will work at the University of Illinois. Dr. I. M. Kolthoff, of the University of Minnesota, has been added to the committee administering the fellowship.

Dr. Austin M. Patterson, professor of chemistry in Antioch College, was elected vice-president of the college at the annual meeting of the board of trustees on May 2.

Dr. Arthur E. Ruark, at present physicist with the Gulf Production Company, has accepted a professorship in the department of physics of the University of Pittsburgh beginning next September to succeed Dr. J. J. Weigle, who leaves to take charge of the department of physics at the University of Geneva, Switzerland.

Professor Withrow Morse, who for the past seven years has directed the department of physiological chemistry and toxicology in the Jefferson Medical College and the work in chemistry of the Jefferson Hospital, retires from the chair and will devote his time to investigation.

Max A. McCall, for the last six years assistant head of the Office of Cereal Crops and Diseases in the Bureau of Plant Industry, U. S. Department of Agriculture, has been named principal agronomist, in charge of this office. Mr. McCall has been acting in charge of the office for the last three months.

Dr. Leon A. Hausman, head of the department of zoology of the New Jersey College for Women, has been appointed consulting ornithologist for the experiment station. In this capacity Dr. Hausman will prepare a number of publications on bird life in New Jersey.

According to *The Experiment Station Record,* Walter Toenjes, research assistant in horticulture at the Michigan Experiment Station, has been appointed superintendent of the Graham Horticultural Substation near Grand Rapids. Franklin Sherman, Jr., was recently appointed research assistant in entomology, *vice* L. G. Gentner, resigned, and Glenn L. Ricks assistant in horticultural research.

David J. Price, Harry E. Roethe and Dr. Lawrence H. James, of the Bureau of Chemistry and Soils, U. S. Department of Agriculture, were named by Secretary Hyde to represent the department on a national committee to study spontaneous heating and ignition of agricultural products, which met in Atlantic City, N. J., on May 13, to formulate plans for and to correlate the various parts of a national research program for dealing with this subject. The committee included representatives of the Bureau of

Mines and of the Bureau of Standards in the Department of Commerce, and representatives of the fertilizer industry, the paint and varnish manufacturers, the feed manufacturers, railroads and steamship companies, insurance companies and other industries which handle stored products.

W. P. STEWART as head of the Virginia Weather Bureau Division has taken up his work as successor to the late Edward A. Evans. Mr. Stewart comes from Milwaukee and has been in the federal service for twenty-nine years.

DR. C. A. ELVEHJEM, of Dane County, Wisconsin, has been appointed to the staff of the department of agricultural chemistry at the University of Wisconsin. Dr. Elvehjem will return shortly from the University of Cambridge, England, where he has been spending the past year studying under a National Research fellowship.

DR. WILLIAM H. HOWELL, director of the Johns Hopkins School of Hygiene and Public Health, has sailed for Europe, where he will attend a meeting of directors of schools of public health in the United States and Europe at Geneva on May 20.

CLYDE C. WHIPPLE, assistant professor of electrical engineering at the Polytechnic Institute of Brooklyn, has been granted leave of absence for one year to serve as visiting professor in electrical engineering at the Green School of Engineering of Princeton University.

DR. LUCIUS H. MERRILL, professor of biological and agricultural chemistry at the University of Maine, has been granted leave of absence and will devote himself largely to his work as state geologist.

DR. C. B. FAWCETT, of University College, London, will be visiting professor in geography at Clark University during the fall semester of 1930–31. He will offer special work on "The Political Geography of the British Empire," and another series of lectures on "The Geography of Continental Europe."

PROFESSOR W. G. WOOLNOUGH, geological adviser to the Commonwealth government of Australia, is spending several months in the United States for the purpose of observing American methods and practices in the petroleum industry and in the administration and technique of official surveys.

DR. JAMES G. NEEDHAM, head of the department of entomology at Cornell University, has recently returned from a 5,000 mile airplane trip to the West Indies and the Guianas with thousands of specimens of dragonflies and their larvae, many of them new to science. In fifty hours of flying, during the two weeks he spent away from the university, Professor Needham visited regions which in the normal course of such an expedition would have required from two to three months to complete and would have entailed hardships and inconveniences which might well have made the trip an impossible one.

A WIRELESS dispatch to *The New York Times* from Adelaide, Australia, dated May 4, reports that Sir Douglas Mawson has announced that with the necessary funds in sight he is now organizing a second Antarctic cruise. He expects to leave Hobart, Tasmania, early in November with members of the staff of the ship *Discovery*. He intends to resume the scientific survey of the Antarctic and to cover an expanse of 1,500 miles lying between the meridian of 160 degrees east and the point farthest east which was reached on his last voyage. Part of this field came within the scope of his expedition of 1911–14. On the forthcoming voyage particular attention will be paid to fishery potentialities, including edible fish, seals and whales.

PROFESSOR DART, of the Witwatersrand University, has, according to the Johannesburg correspondent of the London *Times*, completed arrangements for joining an Italian scientific expedition on its journey through Equatorial Africa and the Nile Valley to Egypt and to Mesopotamia. The expedition is expected to elucidate the relationship between European and African fauna. Professor Dart will also endeavor to throw further light on the question as to whether man appeared first in Africa. The program of the expedition includes visits to the pygmies of the Ituri forests and to the Kivu gorilla country, as well as investigations at Zimbabwe. Professor Dart will examine independently the diseases prevalent in equatorial territories and the circumstances which young medical students might have to face in the equatorial regions.

THE University of Buffalo held its annual scholarship dinner on May 10. Professor Arthur H. Compton, of the University of Chicago, spoke on "Science as a Stimulus to Civilization." Dr. Compton also addressed the Physical Science Club in the afternoon on "Some Aspects of X-ray Scattering."

A SERIES of lectures on the circulation was delivered at the College of Medicine, University of Illinois, by Dr. Walter J. Meek, professor of physiology at the University of Wisconsin, from April 29 to May 1, the titles being, respectively, "Cardiac Output," "Automaticity and Conduction" and "Some X-ray Studies of the Heart."

THE 234th meeting of the Washington Academy of Sciences was held on May 15, when Professor Maynard M. Metcalf, of the Johns Hopkins University, delivered an address on "The Origin and Evolution of the Higher One-celled Animals." This is the sixth of a number of lectures proposed by the academy on various phases of genesis and development or origin and evolution.

Dr. Bernard Hague, principal lecturer in electrical engineering at the University of Glasgow, delivered a lecture on April 26 before the Royal Canadian Institute on "The Contribution of Scientific Research to Some Recent Developments in Electrical Engineering." In September, 1929, Dr. Hague was granted a year's leave of absence to act as visiting professor in the Post Graduate School of the Polytechnic Institute of Brooklyn, New York, to conduct advanced courses in electrical theory and measurements.

The Oliver-Sharpey Lectures before the Royal College of Physicians of London were delivered by Professor J. J. R. Macleod at the college on April 29 and May 1. The subject of the lectures was diabetes as a physiological problem.

The Ingleby Lecture will be delivered at the University of Birmingham on May 22 by Sir John Bland-Sutton, past-president of the Royal College of Surgeons of England. The title of his lecture is "The Blood Trail."

A chapter of Sigma Xi was recently installed at the Pennsylvania State College by Dean Ellery, national secretary, of Union College. There are 82 members of the society or associates on the faculty or connected with it. After the installation, Dean Ellery presented an address on "Radio Activity and the New Chemistry," which was illustrated with moving-picture films.

The fifty-sixth chapter of the Society of the Sigma Xi was inaugurated at the University of Rochester on May 3. The program included a closed meeting, at which Dr. Edward Ellery, professor of chemistry and dean of the faculty at Union College, and national secretary of Sigma Xi, installed new officers. A dinner in his honor was given. Officers of the new chapter are: *Honorary President*, Dr. Herman LeRoy Fairchild, professor emeritus of geology; *President*, Dr. Victor J. Chambers, Charles Frederick Houghton professor of chemistry; *Vice-President*, Dr. George W. Corner, professor at the School of Medicine and Dentistry; *Secretary-Treasurer*, Quantin D. Singewald, assistant professor of geology; *Executive Committee*, Dr. T. Russell Wilkins, professor of physics; Dr. Walter R. Bloor, associate dean of the School of Medicine and Dentistry, and Hazel M. Stanton, psychologist at the Eastman School of Music.

The gift of $1,500,000 by Cyrus H. K. Curtis to the projected Benjamin Franklin memorial and Franklin Institute Museum was announced on May 6 at a luncheon of the Poor Richard Club. Of the amount $500,000 will go to the $5,000,000 fund for the building and $1,000,000 will go to the endowment fund to sustain the museum. Mr. William L. McLean, publisher of the *Evening Bulletin*, Philadelphia, has given $100,000 to be used for erection of a heroic statue of Benjamin Franklin on the Parkway in connection with the proposed Benjamin Franklin Memorial and Franklin Institute Museum.

As a memorial to the late Charles P. Taft, Mrs. Taft has given $2,000,000 to the University of Cincinnati.

Dr. T. Wayland Vaughan, director of the Scripps Institution of Oceanography of the University of California, has given his personal scientific library for addition to that of the institution. This library includes approximately 800 bound volumes and 400 unbound volumes, together with 5,400 reprints. The books number about one ninth the present number in the library; the reprints about one third. Dr. Vaughan already had given the institution library about 150 bound volumes and 500 reprints.

A grant of $10,000 a year for two years has been made by the Rockefeller Foundation to the British National Institute of Industrial Psychology. This is the third grant which the Rockefeller trustees have made to the institute. The first grant, of $50,000, was made in 1926 for a period of five years. Most of this has been spent on research, and several reports will be published this year. The second grant was for $22,500, and was given to enable the institute to move into its present premises at Aldwych House.

Dr. George E. Johnson, secretary, writes that the sixty-second annual meeting of the Kansas Academy of Science was held at the Kansas State Teachers College at Hays, Kansas, April 18 and 19, 1930. Two half days were devoted to general papers and business and one half day to section meetings. Dr. Wm. B. Wilson, of Ottawa University, delivered the presidential address on "The Kansas Academy of Science, its Position and Mission." Dr. T. D. A. Cockerell, of the University of Colorado, addressed the academy in the evening on April 18. His subject was "A Naturalist around the World." An arrangement was entered into with the University of Kansas, the Agricultural College and the Teachers College at Hays, whereby these institutions would contribute annually for ten years towards the publication of the *Transactions*. This also involved giving these institutions copies of the *Transactions* for purposes of exchange. The library of the academy is to be permanently deposited at the three institutions and the exchange list of the academy will be divided among them. The following officers were elected for the ensuing year: *President,* Hazel E. Branch, University of Wichita; *First Vice-president,* Roger C. Smith, Kansas State Agricultural College; *Second Vice-president,* Wm. H. Matthews, Kansas State Teachers College at Pittsburg; *Treasurer,* Ray Q. Brewster, University of Kansas; *Secretary,* George E. Johnson, Kansas State Agricultural College; additional council members, Wm. B. Wilson, Robert Taft, F. U. G. Agrelius and A. W. Barton. The section chairmen are as follows: *Chemistry-Physics,* Robert Taft; *Biology,* Mary T. Harman; *Psychology,* J. C. Peterson, president of the Kansas Psychological Association; *Entomology,* George A. Dean, president of the Kansas Entomological Society. The academy will meet at the university at Lawrence in April, 1930.

A SPECIAL health commission has been appointed by Governor Roosevelt to study the working of the public-health law of New York State and the various state and local authorities dealing with the promotion of health, as well as recent progress in public health in other states and abroad. The announcement of the creation of the commission stated that while New York has "one of the best public health laws of any of the states," and has a state health department which has wide recognition as a leader in its field, the great discoveries in medical science make it desirable every few years to have an appraisal to determine the possibility of a more effective application in actual practice of the latest results of scientific research in the means of preventing disease and conserving health. The governor stated that Dr. Livingston Farrand, president of Cornell University, has been asked to serve as chairman of the commission. Others invited to become members are Dr. George W. Cottis, Jamestown; Dr. Simon Flexner, Homer Folks, Dr. Edward L. Keyes, John A. Kingsbury, Mrs. Henry Goddard Leach, Henry Morgenthau, Gerard Swope, Miss Katherine Tucker and Dr. Linsly R. Williams, all of New York City; Dr. Matthias Nicoll, Jr., White Plains; John M. O'Hanlon, Troy; Dr. Thomas Parran, Jr., state commissioner of health, Albany, and Dr. William H. Ross, Brentwood.

DISCUSSION

THE NATIONAL FOREST RESERVATION COMMISSION AND FOREST RESEARCH RESERVES

READERS of SCIENCE for May 24 and June 28, 1929, will recall that the U. S. Forest Service has announced a policy of setting aside portions of the national forests, representative of virgin or relatively undisturbed conditions in each important forest type, as "research reserves" for scientific study; and that the National Forest Reservation Commission last spring approved the purchase, for its scientific value, of one hundred acres of original growth, known as Heart's Content, as a part of the Allegheny National Forest in Pennsylvania.

The report of the National Forest Reservation Commission to the Senate for the year ending June 30, 1929, will encourage the belief that the Forest Service is now in a much improved situation to carry out its announced policy with respect to research reserves. Owing to the extremely low price at which the bulk of the lands have been purchased for national forests in the East, very little virgin forest is now in federal ownership. Here and there, however, there are within the boundaries set for federal purchases privately owned tracts of original forest growth which, provided the National Forest Reservation Commission is willing to pay the prices asked for heavy commercial stands, may be added to the national forests. The commission's recent report, from the pen of its president *pro tempore,* Ray Lyman Wilbur, Secretary of the Interior, indicates a new attitude toward such purchases. It includes among the objectives of the acquisition program "promotion of reforestation and timber production on forest lands—by creating means for development of the principles and practices of silvicultural management necessary for successful timber-growing." What this phrase means may be inferred from the inclusion among the "outstanding features of the work of the National Forest Reservation Commission for the year" of "recognition of the desirability of the preservation of unmodified or virgin forest areas as nature laboratories for the promotion of silviculture." Further on in the report is the following reference to the purchase of the Heart's Content area:

> Notwithstanding the high commercial value of the heavy stand of white-pine timber, it is deemed eminently desirable that the government should acquire this property, not as a museum site or as a recreational tract but as a laboratory for the promotion of silviculture within which to study both the physical and biological aspects of the changes which take place in such forests, the concomitant changes in the white pine-hemlock forest type and the manner in which knowledge of these changes may be of value in guiding the development and management of the several hundred thousand acres of cut-over white-pine lands eventually to be acquired as the larger part of the Allegheny National Forest.

These principles, applied to future purchase programs, ought to result in the acquisition of other tracts suitable for research reserves. Their area can not, of course, be large, but their value viewed from the scientific point of view will be all out of proportion to their size.

R. D. FORBES

ALLEGHENY FOREST EXPERIMENT
STATION

SAND-STORM ELECTRICITY

THE discussions on atmospheric electricity in SCIENCE[1] called to mind an electrical display which accompanied a sand-storm which I witnessed in 1902.

I was on the White Mountain Apache reservation, in Arizona, on the day in question, when an ordinary desert whirlwind whirled into view from just around a southerly projecting point of land north of White River from the now abandoned Fort Apache. I had just crossed a flat area among the hills where an ancient lava flow once spread out, forming a "lava lake," an area probably six miles across from the afore-mentioned point to the mountainous hills to the northwestward, up which I was then ascending. In a moment it began to gain momentum on entering the level country and in a minute more it was a roaring funnel that was hurling immense quantities of dirt and sand skyward so that they formed an umbrella-like cloud around the apex of the whirling center.

As the twister was coming directly in my direction, I shifted southward over a gulch to another ridge to escape its fury. On it came. It entered the canyon in which I had been only a minute before. Here as the canyon both wedged-in and ascended toward the mountains in the direction it was going, the rushing whirl became "angry," as it were. The day had been perfectly clear. Yet in a moment there were chain lightning and ripping thunder on every side, while at the same time the whirler uprooted trees and tore large-sized boulders from their places on the canyon walls, finally destroying itself in that canyon.

From my observations I am inclined to believe that the electrical display that accompanied this whirl was due to the friction caused by the whirling débris.

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"SOUR SAP" IN TREES OF THE GENUS PRUNUS

ANNUALLY there occurs in stone fruits in the deciduous-fruit-growing sections of California a considerable loss of trees from a disease which is locally known as "sour sap." In certain seasons sporadic epidemics of this trouble occur when thousands of trees, usually from about three to ten or twelve years of age, die suddenly in an unaccountable manner and with no previous warning. The disease is primarily one of winter or early spring. Trees which appeared to be in perfect condition at the end of the season either fail entirely to start the following spring, lose one or more of the main limbs or linger along into the summer only to die before the end of the season. Various climatic combinations have in the past been held responsible for sour sap, although it has never been definitely known at just what time of the winter the initial injury actually develops. The name refers to a condition of the bark or cortex region of affected trees which is attended by decided souring and death of this portion of the host. The disease has been known for many years, and although many attempts have been made to discover the cause or causes of this mysterious trouble, only of late has its true nature been understood.

We have found that there are two distinct souring diseases of trees of the genus Prunus, one caused by bacteria and one due to the presence of stagnant soil water which affects the roots during the early growing period of the host.

The disease caused by bacteria is the more common of the two and is entirely distinct from the other. The bacterial organisms usually attack the host through wounds, such as pruning or grafting cuts, during the winter months and cause a progressive disease of the cortical bark region, usually in the trunk above the bud union or in the main crotches but sometimes killing only certain limbs or one side of the tree. The roots are rarely affected, in fact, an infection in the trunk usually stops its extension abruptly at the surface of the ground and the tree then sends up a mass of suckers from the root. The parenchymatous tissues, including the cambium, are invaded, producing a highly discolored, plasmolyzed appearance with a water-soaked, very sour advance, in which bacteria can be seen in the cells and in the intercellular spaces. The bacteria are usually present in zoogloeal masses but at times are quite free and motile. Extensive epidemics of this disease occur only in occasional seasons at irregular intervals, and it seems certain that some correlation must exist between certain seasonal climatic or soil moisture conditions and the development of sour sap. While many theories have existed in regard to this correlation we have really no definite information at all as to the nature of these conditions or even as to the specific time when they occur.

Our work covers a period of seven years of field observations and three years of inoculation experiments on a wide range of Prunus species and varieties, including peach, cherry, wild and cultivated plums, apricot and almond, with the result that the typical condition has been reproduced in all the above hosts. No one bacterial species is constantly associated with the trouble, and up to the present time we have isolated six types, each of which has caused extensive lesions in susceptible hosts when inoculated from pure cultures. Only during the months of December, January and February has this condition been induced experimentally; before and after this period small lesions develop but rarely damage the trees to any extent.

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[1] March 30, 1928; May 3, 1929; October 18, 1929, and January 24, 1930.

The souring of trees caused by stagnant soil water is prominent at times during the spring when the trees are starting into leaf. Trees standing in water which is moving through the soil are not damaged, but those subjected to stagnant water suffer in proportion to the damage to the roots. The leaves turn yellow, wilt as though lacking moisture, become brown at the edges and finally die. The affected roots become highly discolored and sour and die, while those not injured remain normal and continue to support the corresponding upper portion of the trees. In these cases a portion of the affected tree remains alive and continues growth. There are all gradations of top effect, and many cases recover if the water is drained off.

Many trees affected with sour sap of either of the above types become also infected with bacterial gummosis, which further complicates the question of the primary etiology of the trouble.

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SILVER OR GOLD

As a rule silver tarnishes to a greasy black color. I have found silver articles in the Near East which fail to blacken on weathering, but instead, become coated with a film of golden hue. One would think that the silver had been gold-plated. I investigated this interesting fact and discovered that silver originating in Caucasian deposits was particularly capable of this type of tarnishing. Apparently the small platinum content or the presence of some of the similar rare metals is responsible for this phenomenon.

Antique dress jackets of the Near Easterners, made of beautiful purple velvet and decorated with what seems to be gold braid, are to be found in the bazaars. This gold braid is silver—there is no trace of gold in it. Silver braid was used and in the course of time it tarnished to the gold color. Slightly rubbing it with a jeweler's touchstone reveals the silver beneath the outer film.

Two pieces of old Russian silverware, formerly used by the late czar of Russia, were presented to me. These were highly polished when given me. They are now beginning to exhibit this characteristic tarnish.

Some silver "Alexander the Great" coins which I unearthed in Macedonia fail to show this tarnish. The origin of the silver of these coins is probably Macedonia. Although silver is not found in Macedonia now, we do know that the early Greeks did find it along the banks of the Exidoros.

Perhaps all that glittered on the royal purple robes was not gold but silver!

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REPORTS

THE AMERICAN MUSEUM OF NATURAL HISTORY

DEFINITE plans to seek, through gifts from the public, $10,000,000 added endowment for the scientific and educational work of the American Museum of Natural History were adopted on May 5 by the trustees at their sixty-first annual spring meeting. The board confirmed selection of a committee, with President Henry Fairfield Osborn as chairman, to present actively during the balance of the year in the metropolitan area and throughout the country the needs of the institution.

This action followed submission of the annual report of the museum by President Osborn, who emphasized that mounting costs since the war and increasing demands for expansion of the museum's functions had brought about a severe financial stringency. Many important activities, he stated, were at a standstill or below normal, while projects necessary to keep the museum in its position of leadership in science and public usefulness were in abeyance.

"We are held back internally, while outwardly we are prospering," said President Osborn. "Annual public support of the museum, though increased, continues to fall far short of even the routine needs. Only the heavy emergency contributions by trustees have prevented the discharge of a large number of employees, but the budget thus temporarily balanced covers little more than ordinary maintenance for 1930. It holds no guarantee for succeeding years, and it has not prevented a sharp curtailment of the scientific work which is the very being of the museum and the basis not only of its prestige but of its unique service to the city, the state, the nation and the world at large.

"If the museum, which has become the particular pride of the people of metropolitan New York and virtually a household word all over the globe, is to continue its brilliant record of achievement, thus far unbroken since its founding in 1869, it should have no less than $500,000 more in annual income. This would be accomplished by the sixtieth anniversary endowment fund of $10,000,000, first proposed some time ago, but thus far not vigorously advanced. So alarmingly urgent has become our situation that we can delay no longer. It is to be hoped that the next annual report will see this fund substantially in hand or promised."

Serving with President Osborn as a preliminary committee will be the following trustees: Treasurer James H. Perkins, Secretary S. Brinckerhoff Thorne, George T. Bowdoin, Douglas Burden, Cleveland E. Dodge, Clarence L. Hay, Junius S. Morgan, Jr., A. Perry Osborn, Daniel E. Pomeroy, Henry W. Sage, Leonard C. Sanford and Felix M. Warburg. George H. Sherwood, director of the museum, will be secretary of the committee.

Reviewing in his annual report the museum's status, which he declared was now threatened by lack of funds, President Osborn said: "All wealth and all health comes from knowledge of nature, and the American Museum of Natural History is advancing the knowledge of nature and the inspiration of nature on a scale unknown before in the whole history of education and of civilization."

But the present budget, he stated, was only "a minimum working budget," which had recently failed to cover some of the most valuable of the museum's activities. "Our explorations," he continued, "our researches, our expeditions, our publications, our educational work in school, college and university, our library, are suffering for want of adequate financial support to overcome the doubling or trebling of all costs since the fatal year 1914.

"The department of public health is entirely suspended; the library is very seriously crippled; were it not for Mr. Childs Frick's gifts, the department of vertebrate paleontology would have to stop its expeditionary work; other departments, like geology and geography and invertebrate paleontology, are operating at half their former rate; although under very able leadership, entomology is short-handed, and in practically all the exhibition halls of the museum the work of completing educational equipment has stopped.

"The two departments in which late President Morris K. Jesup was deeply interested, namely, woods and forestry and anthropology in all its branches, are restricted severely by retrenchment and undermanned."

Reporting on educational and scientific work of the museum, Director Sherwood noted the loss by death or resignation of seven members of the scientific staff, and added: "These men were all experts in their respective fields. It has been impossible to replace them because of the present critical financial emergency of the museum. In the depletion of our scientific personnel, research and publication are seriously retarded, and the museum is losing prestige in science.

"Overhead expenses must go on. They have had to be met at the expense of exploration, research and publication. The necessary financial retrenchment has reduced to a minimum the allowance for the research and publication side of the museum, until in 1929 almost none of the normal income could be devoted to exploration, which consequently has had to depend upon the special gifts of friends. When this situation is considered in conjunction with the museum's severe losses in scientific personnel the disastrous effect upon our scientific progress must be evident."

The income of the sixtieth anniversary endowment fund, it was announced by President Osborn, would be allotted for permanent support of exploration, research and publication; for additional assistants, to release curators and research workers for scientific projects and publication; for raising staff salaries to university and college grades; for the educational equipment and modernizing of the fifty old and new exhibition halls completed or under construction; for intensive high school, college and university education in laboratories and exhibition halls; for extension of the educational service, now reaching more than 1,000,000 public school children, to secondary schools; for preparation of existing exhibitions and collections to render the highest educational service to students and the visiting public, and for purchase of books to aid in the research activities. Provision also must be made, it was stated, for the development of future plans in connection with the addition of a new building section by the state and three new sections by the city, under the arrangement whereby the city provides land and buildings, and trustees and public the scientific work and the exhibitions.

G. N. P.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

HIGH FREQUENCY EQUIPMENT FOR BIOLOGICAL EXPERIMENTATION

Growing interest in the biological utilization of the electromagnetic spectrum in the range of frequencies made available by improvements in the three electrode vacuum tube has led to the design of a convenient apparatus for treatment of the usual laboratory animals and materials.

With the apparatus here described high frequency fields can be applied to a wide variety of forms—from the smallest of insects to large rats. It has been found that very small objects require a concentration of the field and this requirement has been met by an arrangement for quick and easy interchange of plates in the exposure circuit, the subsequent tuning being accomplished merely by shifting an ammeter shunt along two parallel bars.

Frequencies from about 150.000.000 cycles per second (2 meters) to about 50.000.000 cycles per second (6 meters) are available. The circuit generating these frequencies is similar to those used by Schereschewsky[1] and Christie,[2] and the range is sufficient to cover that part of the spectrum found by Schereschewsky to be the most promising. The output on the exposure circuit can be conveniently controlled from 0 to about 4.5 amperes, the maximum being high enough to kill insects in a few seconds and mice or other small laboratory animals in from three to ten minutes.

The generating and exposure circuits are mounted on a wooden base built in the form of a stair step, the generating circuit being above and back of the exposure circuit. The overall length is thirty-nine inches, the height ten inches and the width fifteen inches. A slanting panel connects the two levels of the step, and the transformers, rheostat, fuses, etc., are placed behind this panel (Fig. 1).

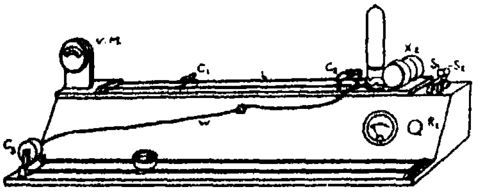

FIG. 1

In the accompanying diagram of this high frequency generator the generating circuit is shown at A and the exposure circuit at B (Fig. 2). The supply voltage for the filament and the plate of the vacuum tube is obtained from 110 volt, A. C., source. Five ampere fuses are used on the A. C. leads.

The transformer T_1 supplies current for heating the tube filament. An Acme 100 watt, filament lighting transformer is used. The primary voltage is 110 volts at 60 cycles and the secondary voltage is 12. Transformer T_2 supplies the plate voltage; it is rated at 100 watts, 110 volts primary, 1100 volts secondary. Two small 15 ampere S. P. S. T. knife switches are provided, S_2 controlling the filament current and S_1 the plate voltage.

At X_1 is a small high frequency choke in series with the plate transformer winding and with the oscillator inductance rod L. It is composed of about fifty turns of No. 36 D. S. C. magnet wire wound on a ¼-inch tube of insulating material. It may be omitted if the transformer is located at some distance from the oscillator. At R_1 is a grid leak resistor. It is not critical and may be of from 5.000 to 10.000 ohms.

The by-pass condenser C_1 must be of such insulation as to stand the plate voltage. A Sangamo 250 micro-microfarad condenser sealed in bakelite is satisfactory. A tuning condenser is placed at C_2. It is a small two-plate variable condenser and was made by removing all but one stationary and one rotary plate from a General Radio 15 micro-microfarad variable condenser. At X_2 are two high frequency chokes made by winding about fifteen turns of No. 14 copper wire on a 2½-inch diameter tube.

The rheostat at R_2 is for the control of the filament current. Almost any type of .5 ohm rating will do. It should be of such resistance and current capacity as to limit the filament current to about 6.25 amperes when used in conjunction with the filament transformer above described. The ammeter A on the generating circuit provides a check on the filament current. A Jewell, pattern No. 74, 0–8 amperes, A. C., is satisfactory.

The inductance rods L, upon which C_1 slides, are ¼-inch copper tubes about 22 inches long. They may be of any length depending upon the highest wavelength desired. The separation of the two rods at L alters their inductance materially as well as their high frequency resistance, and, for this reason, a separation of less than two inches is not recommended. In this instance the separation is 2.25 inches.

By changing the position of the by-pass condenser C_1 along these rods a means is provided for changing the inductance in the oscillatory circuit, and hence the frequency. As a means of fine adjustment to a predetermined frequency, the small variable condenser C_2 is connected at the base of the tube. The actual frequencies generated may be conveniently measured by the Leecher wire system.

The exposure circuit is similar to the oscillatory circuit except that here the vacuum tube capacity has been replaced by the condenser plates C_3. It is between these plates that the actual exposure of experimental material is made. Both the oscillatory and exposure circuits are shown in the diagram (Fig. 2) by heavy lines.

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[1] J. W. Schereschewsky, Public Health Service Bulletin, 1926, p. 1939; Public Health Service Bulletin, 1928, p. 927.

[2] R. V. Christie and A. L. Loomis, *Journal of Experimental Medicine*, 49, v. 2, 1929.

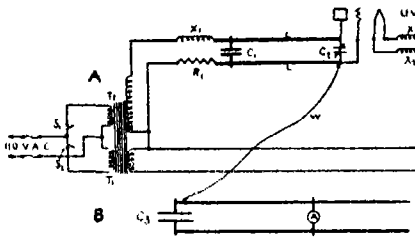

FIG. 2. Generating and exposure circuits.

On the exposure circuit there are also two parallel rods of ¼-inch copper tubing, in this case at 3½ inches separation; and, in order to give sufficient tuning range, they are 34 inches long. Along these rods, acting as a shunt, slides the ammeter A of the exposure circuit. This ammeter provides a means of determining the point of resonance of the circuit, and also a relative measure of the output. A Jewell, pattern No. 64, Radio Frequency, 0–5 amperes, is used. The actual tuning of the exposure circuit may be accomplished either by changing the position of the ammeter along the two parallel rods or by changing the separation of the condenser plate C_3.

Two metal posts about four inches high hold the condenser plates at C_3. These posts are connected at their bases with the two parallel rods; they may be insulated by a cross member of bakelite or some other insulating material. Although not absolutely necessary, the whole of the exposure circuit may be insulated from its wooden support. The plate posts are drilled and threaded for a ¼-inch bolt. Circular sheet copper plates of varying size may be screwed to these bolts by soldering the proper-sized nut to the back of each plate.

Coupling between the oscillatory and the exposure circuits presents somewhat of a problem when dealing with frequencies as high as here used. It has been found best to use a very loose inductive coupling and then provide a single wire feeder much like the usual radio antenna feeder. This wire feeder is shown at W on the circuit diagram. The coupling may be varied by changing the position of the feeder clip on the grid inductance rod of the oscillator. However, in practice it has been found that little change in coupling is required.

Several types of standard vacuum tubes could be adapted to this apparatus, but the UV 203, 50 watt tube has proved very satisfactory. It has a high filament emission as compared to tubes with thoriated filaments, and it gives sufficient output for nearly all kinds of biological experimentation. With this tube the lowest wave-length available is about three meters, although it is possible by tuning to the second harmonic on the exposure circuit to use a wave-length of less than two meters. Higher wave-lengths are easily obtained by extending the length of the rods in the oscillatory circuit. For lower wave-lengths a push pull oscillator composed of tubes of very low internal capacity is necessary. Amplifiers to increase the output of vacuum tube oscillators at these wave-lengths have not proved satisfactory.

To the apparatus here described may be added an A. C. voltmeter at the 110 volt A. C. source. If it is desired, larger animals than rats may be treated by adding a set of square exposure plates of large size and wide separation. These plates may be mounted on the slanting panel and connected by copper rod feeders to the exposure circuit.

All the parts listed are standard electrical equipment and may be obtained from radio supply houses at remarkably low cost.

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REDUCING MOISTURE EVAPORATION FROM PETRI DISH CULTURES

GROWTH-RATE studies and other laboratory studies of wood-rotting fungi require a constant moisture content of the wood upon which such tests are made. This is essential to the control of the moisture factor, which is an extremely important one in all such studies. In one of the growth-rate studies now under way, octagonal disks of wood 3″ x 3″ x ½″, having a moisture content of 100 per cent. oven-dry basis, were placed in 100 mm x 15 mm Petri dishes, inoculated with the fungus and then placed in an incubator at 27° C. In a few days it was observed that a loss of water from the wood disk by evaporation through the space between the two parts of the dish proceeded at such a rapid rate that growth of the mycelium was inhibited, and if continued for a longer period death of the fungus resulted.

To prevent this loss of water, it was suggested that the space between the cover and the bottom of the dish be filled with a plastic, impervious substance, such as modeling clay, paraffin or beeswax. However, the inconvenience of sterilizing, then introducing these materials into the crevice, presented difficulties that were reduced by the use of another method. This method is simple but effective and consists in the application of a wide rubber band to the periphery of the dish so that it covers the opening between the two parts and overlaps on the bottom and top sufficiently to prevent slipping off (Fig. 1). The bands were especially made by A. W. Faber in two sizes, 3⅜″ long by 2″ wide, for use with Petri dishes of 15 mm depth, and 3⅜″ x 1⅜″ for those of less depth.

The rubber is of the same weight as that used in Faber's large, office band, 3⅜″ x ¾″. These sizes fit snugly, with no loose edges, and leave the top of the dish unobstructed for observation and measurements.

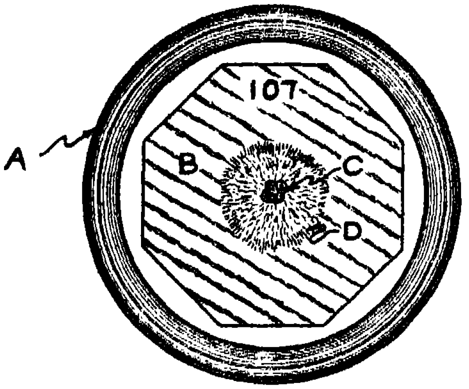

FIG. 1. Drawing showing the wide rubber band A, surrounding the edge of the Petri dish, in which is enclosed the flat, octagonal piece of moist wood, B. The *fungous inoculum* is shown at C, and the mycelium which spreads from it is indicated at D. The number, 107, indicates the number of the test piece.

The band method greatly reduces water loss, though it does not completely prevent it. The average loss per week when using bands was shown to be from 0.2 to 0.4 of a gram per dish containing wood test pieces at 100 per cent. moisture content, whereas without any protection this loss is from 2.0 to 3.8 grams. The difference is so marked that further explanation is unnecessary.

This method is applicable to toxicity tests of wood preservatives, studies in the decay resistance of woods, the determination of moisture and temperature requirements of fungi, cultural tests of various kinds and to a variety of uses where controlled moisture conditions are desired for test materials or living organisms contained in Petri dishes.

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SPECIAL ARTICLES

THE DISPLACEMENT OF TOXIN FROM NEUTRALIZED TOXIN-ANTITOXIN MIXTURES BY "TOXOID" OR ANATOXIN

MADSEN and S. Schmidt[1] have recently shown that neutralized toxin-antitoxin mixtures become toxic on addition of anatoxin. Schmidt[2] also showed that "toxoid" exerted the same effect and concluded that toxoid and anatoxin have a greater affinity for antitoxin than the original toxin itself, and can therefore displace it.

The tendency of recent immunological work (Obermayer and Pick, Landsteiner, Avery and Goebel) has been to show that even minute alterations in the structure of an antigen diminish an existing specificity rather than augment it, so that it would seem preferable to seek some other explanation.

This can readily be found in the conception of Arrhenius and Madsen[3] that the toxin-antitoxin reaction is a reversible chemical equilibrium of the type $T + A \rightleftarrows TA$, to use the simplest possible form, in which $T =$ toxin and $A =$ antitoxin. Letting this equation represent a "neutralized" mixture, we may express the equilibrium state by $\frac{[T][A]}{[TA]} = K$, or $[T][A] = K\,[TA]$, in which K is the equilibrium constant and the bracketed letters refer to concentrations. Since the toxin in the mixture is "neutralized," [T], and consequently K, are relatively small at equilibrium.

If the concentration of any of the reactants is changed the relative quantities of the other constituents also change so that K remains constant. Thus, if an additional amount of T is added it reacts with part of the A, decreasing [A] and increasing [TA], thus keeping K constant. If some other substance capable of reacting with A is added, [A] will also be decreased, but to keep K constant some of the TA will dissociate, increasing [T] and decreasing [TA].

Such a condition would arise when anatoxin or toxoid is added to a neutralized toxin-antitoxin mixture. If toxoid (Td) reacts with antitoxin in the same way that toxin does, $Td + A \rightleftarrows TdA$, a similar mass-law expression may be formulated, namely: $\frac{[Td][A]}{[TdA]} = K'$.

If toxoid is now added to a mixture containing neutralized toxin, the component substances will interact until their concentrations fulfil the conditions of the mass law equations $\frac{[Td][A]}{[TdA]} = K'$ and $\frac{[T][A]}{[TA]} = K$. As [A] is common to both expressions a relationship between [T] and [Td] can be derived, namely, $\frac{K[TA]}{[T]} = \frac{K'[TdA]}{[Td]}$. If the assumptions are made that one equivalent of TA is present before addition of one equivalent of Td, that the concentrations of free T and A in a "neutralized" mixture are negligible and that x equivalents of TdA are formed at the expense of TA, the expression at equilibrium would be $\frac{K[1-x]}{[x]} = \frac{K'\ [x]}{[1-x]}$.

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[1] T. Madsen and S. Schmidt, *Compt. rend. soc. biol.*, 102: 1091, 1929.

[2] S. Schmidt, *ibid.*, 1095.

[3] Arrhenius, "Immunochemistry," Chapters VI and VII, New York, 1907.

This would, of course, be strictly true only if K is so small that essentially all of A is in the form of TA. If $K = K'$, that is, if T and Td have the same affinity for A, $x = 0.5$. In other words, one half of the toxoid added has combined with the antitoxin and half of the toxin has been liberated.

If $K = 0.5\ K'$ (Td has 0.5 the affinity of T for A),

$$x = 0.41;$$
$$\text{if } K = 0.1\ K', \quad x = 0.24;$$
$$\text{if } K = 0.01\ K', \quad x = 0.09.$$

Thus, in the case considered, even if T has one hundred times the affinity of Td for A, an appreciable amount of toxin would be liberated from the neutralized mixture by the addition of Td. Actually, the greater the value of K, the smaller the amount of toxin liberated, since free A would be greater and less dissociation of TA would occur. However, if one accepts the experimental results of Madsen and Schmidt, as well as the explanation herein given, K must be relatively small, since liberation of toxin is actually observed.

Interesting in this connection is the analogy to the toxin-toxoid reaction pointed out some years ago by Northrop;[4] namely, that a pepsin-albumin mixture diluted with inactivated pepsin contains more active pepsin than one diluted with buffer alone, the effect being in harmony with the hypothesis that inactivated pepsin, as well as active pepsin, combines with the peptone formed by digestion of the protein.

A simple physicochemical consideration of the conditions of equilibrium therefore suffices to account for the increase in toxicity of neutralized toxin-antitoxin mixtures to which toxoid or anatoxin has been added, and the experimentally untouched affinity relations of these as yet vaguely defined substances need not be taken into account.[5]

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A NEW LAW OF SATELLITE DISTANCES

BESIDES the celebrated Bode's (or Titius) law there have been a number of attempts to establish a law governing the distances of satellites from their central body, including two discussions of the subject in SCIENCE in 1929. My approach to this subject was made about four years ago in somewhat the same manner as that of Dr. A. E. Caswell[1] who holds "the mean distances of the planets from the sun are proportional to the squares of simple integral numbers." I added, however, to the square of the integer the integer itself, thus assuming that the terms differ from the squares of integers by a progressively changing amount. For example, adding to each of the integers 1, 2, 3, 4, 5 . . . its square, we obtain the values 2, 6, 12, 20, 30. . . . This is simplified by dividing throughout by 2, giving us the series 1, 3, 6, 10, 15. . . . Those familiar with Bernoulli's *Tabula Combinatoria*[2] will recognize the series as the ternaries of his table.

The following table shows the results for all the satellite systems, including the planets as satellites of the sun, of the solar system where there are at least

TABLE ILLUSTRATING LAWS OF SATELLITE DISTANCES

System	Satellite	Relative Distance	New Law	Bode's Law	Caswell's Law
Sun	Mercury	3.87	3	4	3.82
"	Venus	7.23	6	7	6.80
"	Earth	10.0	10	10	10.6
"	Mars	15.2	15	16	15.3
"	Ceres	27.7	28	28	27.2
"	Jupiter	52.0	55	52	51.4
"	Saturn	95.3	91	100	95.6
"	Uranus	191.0	190	196	187.0
"	Neptune	300.0	300	....	310.0
'	"Planet X"	400.0	406	388	408.0
		430.0	435	388	435.0
Mars	Phobos	1.00	1	....	1.70(?)
"	Deimos	3.22	3	4	3.82
Jupiter	V	2.71	3	4	3.82
"	I (Io)	6.27	6	7	6.80
"	II (Europa)	10.0	10	10	10.6
"	III (Ganymede)	15.8	15	16	15.3
"	IV (Callisto)	27.9	28	28	27.2
"	VI	169.4	171	....	170.0
"	VII	173.0	171	196	170.0
"	VIII	348.5	351	....	357.0
"	IX	371.0	378	388	382.0
Saturn	Mimas	10.0	10	10	10.6
"	Enceladus	12.8	....	....	....
"	Tethys	15.8	15	16	15.3
"	Dione	20.3	21	....	20.8
"	Rhea	28.0	28	28	27.2
"	Titan	66.0	66	52	61.2
"	Themis	78.1	78	....	83.1
"	Hyperion	79.0	78	100	83.1
"	Iapetus	190.0	190	196	187.0
"	Phoebe	698.0	703	772	712.0
Uranus	Ariel	10.0	10	10	10.6
"	Umbriel	14.1	15	16	15.3
"	Titania	22.8	21	....	20.8
"	Oberon	30.4	28	28	27.2

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[4] J. H. Northrop, *J. Gen. Physiol.*, 2: 482, 1919–20.

[5] The authors of this paper are working under the Harkness Research Fund of Presbyterian Hospital.

[1] A. E. Caswell, "A Relation between the Mean Distances of the Planets from the Sun," SCIENCE, n.s., 69: 384, 1929.

[2] D. E. Smith, "Source Book in Mathematics," p. 272, 1929.

two known satellites on which to base comparisons. The base term for the relative distances in each satellite system is 10 except in the case of Mars where it is one. Distances under Bode's law (represented by the series 4, 7, 10, 16, 28, 52, 100, 196, 388 and 772) are included not only for comparison of the results with those of the new law but also because that law gives very good values for some of the planetary satellites as well as for those of the sun. Likewise the distances under Dr. Caswell's law are included. These are obtained as explained in his article in SCIENCE.[1]

The new "Planet X" has been officially reported in a circular from the Lowell Observatory as having a distance from the sun of 40 to 43 astronomical units. Therefore double values have been included in the table until a more accurate determination of the distance is made. Enceladus, the second satellite of Saturn, does not, apparently, belong to any of the three series, but it is here included for completeness. The orbit of Themis is not accurately determined, but it seems that there may be a faint satellite at about the distance given. If in the satellite system of Mars 10 be taken as the relative distance for Deimos, better values will be obtained for the Bode and Caswell series, but the value of one was adopted for Phobos instead because of the near correspondence of the distance of that satellite to that set by Roche's limit. Ceres, the largest of the asteroids, is included in the table although it may belong to a system of harmonics rather than to the fundamental series. Referring to the table, it is seen, of course, that not all of the successive terms of the new law are represented in any one satellite system nor are the same terms represented in different systems.

It is important to notice that Bode's law gives fairly good values for at least five of Jupiter's satellites, for four of those of Saturn and for three of those of Uranus. This fact seems to be overlooked in nearly all modern popular discussions although it was referred to in some articles fifty years ago. Sir James Jeans,[3] like many others, has said ". . . it seems more than likely that it [Bode's law] is a mere coincidence with no underlying rational explanation." Yet Bode's law is an approximation for several terms both of Dr. Caswell's law and of my own, and Dr. Caswell[1] believes that his series "suggests the possibility that the orbits of the planets may be 'quantized' somewhat after the manner of the electronic orbits in the Bohr atom." The quantum principle is important in wave-theory, and my own solution resulted from studies in that field. The new series can be derived by taking the fiction, employed in the mathematics of a vibrating sphere, of a double source of wave-action of suitable strength at the center of the sphere and by modifying this concept to that of two sources of wave-action whose distance apart is relatively small in comparison with the length of the waves set up in the surrounding medium. Then, by disregarding the distance apart of the two sources, it is possible to develop the series by superposition. This assumes that the solar system can be treated somewhat on the order of the Schrödinger[4] atom rather than that of Bohr. A French writer, Lieutenant-Colonel Delaunay,[5] also believes wave-action is important in this problem. Finally, Victor Goldschmidt, of Heidelberg, according to Dr. Malisoff,[6] has shown that "a mathematical treatment strictly analogous to the phenomena of *standing waves in sound*, the distribution of lines in spectra, the progress of crystallization and similar phenomena gives the same law of harmonic relations of distances not only for the planets but also for satellites." Referring to Goldschmidt's[7] original article, I find that he has represented the distances of the planets as follows: Mercury 3.90; Venus 7.10; Earth 10.0; Mars 16.7; Jupiter 50.0; Saturn 100; Uranus 200; Neptune 300, and (following his method) "Planet X" 400. Dr. Caswell[1] has given it as his opinion that "on the whole the agreement is good, and can scarcely be accidental." After considering all this evidence independently arrived at by different investigators I am disposed to agree with him and offer as my opinion that Bode's law, as a first approximation, may have its origin in actual causal phenomena.

J. B. PENNISTON

SEATTLE, WASHINGTON

THE NATIONAL ACADEMY OF SCIENCES

AT the annual meeting of the National Academy of Sciences, held in Washington on April 28, 29 and 30, the following papers were presented:

The structural basis of the integration of behavior: G. E. COGHILL (introduced by C. Judson Herrick). The development of behavior in a lower vertebrate, in which movements can be observed from the first muscular contraction to the adult condition, is a process of expansion of a pattern which is from the first always integrated. Within this integrated total pattern partial patterns such as reflexes emerge with varying degrees of individuality of their own. This is accomplished by a progressive restriction of the field of adequate stimulation of the partial patterns as well as of the patterns themselves. This law is also exemplified in the structural development of the nervous system, and apparently holds for higher vertebrates and man. It is the unifying principle which brings order out of the chaos which has hitherto prevailed as regards various categories of behavior, such as simple reflexes, chain reflexes, conditioned reflexes, instincts, habits, trial and error.

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[3] Sir James Jeans, ''The Universe around Us,'' p. 20, 1929.

[4] Arthur Haas, ''Materiewellen und Quantenmechanik'' (p. 81 in Eng. trans. by L. W. Cobb, ''Wave Mechanics and the New Quantum Theory,'' London, 1928).

[5] Lieutenant-Colonel Delaunay, ''Problèmes Astronomiques,'' Paris, 1920.

[6] William Marias Malisoff, ''Some New Laws for the Solar System,'' SCIENCE, n.s., 70: 328–329, 1929.

[7] Victor Goldschmidt, ''Über Harmonie in Weltraum, ein Beitrag zur Kosmogonie,'' *Annalen der Naturphilosophie*, 5: 51–118, Leipzig, 1906.

Localization of function in the nervous system: C. Judson Herrick. Analytic functions, such as specific reflexes, are performed by precisely localized organs. Synthetic or integrative functions seem to pertain to the organism as a whole. But these too have organs; they are not disembodied; and our problem is: What is this apparatus? Genetically, specific local reflexes arise within and are derived from mass-movements or total reactions (Coghill). Parallel with elaboration of these localized reflex arcs, special integrating apparatus is developed—the diffuse nervous felt-work, or neuropil. This is the parent tissue from which the mechanisms of all higher nervous functions are differentiated—correlation, association, learning, memory, intelligence. This apparatus of the personality as a whole has location in space, but the pattern of this localization is radically different from that of specific reflexes, and the pattern of performance is different.

Observations on asphyxia bearing upon the adjustment of respiration to diminished pressures of oxygen at great altitudes: Yandell Henderson and Ellen M. Radloff. Healthy men who ascend such mountains as the Himalayas, requiring several weeks, develop an acclimatization which permits them to be comfortable and even to make great physical exertions. If, on the other hand, the ascent to such altitudes is made in a few hours by balloon or railroad train, as in the Andes, intense mountain sickness, physical incapacity and even death may result. The study of the process of acclimatization has shown that the volume of breathing per unit of gaseous exchange in acclimatized men corresponds to the decreased pressure of oxygen. The primary increase of breathing might be due either to accumulation of lactic acid and other incomplete combustion products or to a primary effect of low oxygen inducing over-breathing and thus rendering the blood temporarily more alkaline than normally. The results of our investigation of the changes in the blood in dogs during asphyxia favor the latter conception.

Virus disease and the central nervous system: Simon Flexner. By a virus disease is meant one induced by a micro-organism so small that it has not been rendered visible by the most powerful microscope. Such micro-organisms or viruses are, because of their minute size, capable of passing through the pores of earthenware filters, which hold back ordinary bacteria. This property has led to these viruses being called "filter passers" or "filterable viruses." Viruses produce disease in plants and in many, if not all, orders of animals. The particular interest which they have for us to-day depends upon the fact that they are not only responsible for severe diseases among mammals, including man, but that the diseases are often attended by symptoms indicating involvement of the central nervous system. Poliomyelitis, or infantile paralysis, is an excellent example of this condition; another is rabies, or hydrophobia. In smallpox, measles and certain other virus diseases of man it occasionally happens that the central nervous system is affected, in which case the gravity of the original disease is intensified. In domestic mammals virus diseases attended by nervous complications are found among horses (Borna's disease), rabbits, guinea-pigs, dogs (distemper), etc. In certain instances the virus diseases of the lower animals are communicable to man (*e.g.*, psittacosis, or parrot disease); on the other hand, virus diseases of man can be communicated to the lower animals (*e.g.*, poliomyelitis, typhus fever, yellow fever). We are just beginning to learn the frequency with which the central nervous system is involved in the virus diseases of man and of animals. It appears that the viruses themselves may be divided into two classes: (1) those which tend to attack the central nervous system predominantly, and (2) those which attack other organs with greater intensity and frequency than the central nervous system. The first class of viruses produces diseases which are in essence affections of the central nervous system; the second class, diseases in which affections of the nervous system are more in the nature of complications than of essential disease.

Biological studies of the tubercle bacillus—(1) *Instability of the organism—Microbic dissociation:* S. A. Petroff (introduced by Hans Zinsser). It has been increasingly evident during recent years that bacteria along with the other living forms are subject to modification. From the accumulated evidence in the last fifty years it seems that the tubercle bacillus, which has been considered by many investigators as one of the most stable micro-organisms, is also subject to modification. No explanation has been offered as to the cause of the morphological, cultural and virulence variations. In this paper we shall discuss the instability and microbic dissociation of the tubercle bacillus, for the study of which new methods and media have been devised. (*a*) Three types of colonies have been dissociated from the avian tubercle bacilli. One is perfectly round, smooth and appears like moth-ball, is easily emulsified, grows best on alkaline media and is highly pathogenic for chickens. The second type is flat, moist, with smooth surface, and is emulsified with difficulty. The third type is flat and dry, the center giving the appearance of small pebbles. This colony is also difficult to emulsify. The second and third types are not so virulent for chickens as the first. (*b*) Three types of colonies have been isolated from a bovine tubercle bacillus culture grown on special gentian-violet egg media. One is perfectly round, smooth, moist, appears as moth-ball, emulsifies easily and grows best on alkaline media. Morphologically it is composed of small intact rods, and granules are absent. The organism is highly pathogenic for guinea-pigs and rabbits. The second type is flat, with a moist smooth surface and raised center. It grows best on acid media. The rods are longer and beaded. It produces less extensive tuberculosis in laboratory animals. The third is flat, dry and the structure appears like small pebbles. It emulsifies with difficulty in salt solution and is only sometimes pathogenic for guinea-pigs and rabbits. (*c*) From the BGG cultures, we have dissociated two extreme types of colonies. One is large, flat, with large folds, appears very waxy, grows best on acid media and is not pathogenic for guinea-pigs or rabbits. The second is a large flat colony, the center appears like honey-comb and the periphery is veil-like. It grows best on alkaline media and is pathogenic for guinea-pigs and slightly for rabbits. (*d*) The human tubercle bacillus has not been completely dissociated. It seems that this organism presents large numbers of variant colonies, which are quite unstable. Some of these colonies have been successfully reverted, one into the other, by a special method of cultivation. It seems that the tubercle bacillus as compared with other organisms is also quite unstable. The studies indicate that the factor of instability must be taken into consideration when discussing any problem in tuberculosis.

The architecture of living cells. Optical sectioning with the ultra-violet microscope: FRANCIS F. LUCAS (by invitation). This paper describes a new tool for biological research. It is the ultra-violet microscope perfected and reduced to practice. With new technique it is possible to section optically living normal and malignant cells and to photograph them at very high magnifications and with a degree of resolution never heretofore achieved. The average living cell is about 1/3,000 inch in diameter. This living cell, itself invisible to the unaided eye, is "sliced" into sections spaced about 1/100,000 inch apart and photographs of each section are taken without materially interfering with the normal behavior of the cell. In the average cell thirty or even more photographs may be taken on uniformly spaced optical planes. At magnifications as high as 5,000 diameters the interior architecture of living cells is photographed. By virtue of the invisible monochromatic ultra-violet light which is used the resolving ability of the system is about twice that by other known means. The apparatus is briefly described and illustrated and photographs are included of the structure of normal and malignant living cells. Several photographs show the sectioning method applied to living brain cells.

The sense of hearing in fishes: KARL VON FRISCH (introduced by R. G. Harrison). Fishes (minnows, *Phoxinus laevis*) can be trained to react to sounds of whistles, tuning-forks, etc. They are fed from a glass rod and at the same time the training sound is given. The sense of sight is eliminated by blinding. After some days the fish gives a very typical reaction to sound. It snaps and seeks for the food at once when the sound is given, before the food is put into the water. The upper limit in minnows is between 4,000 and 7,000 v.d. The low limit could not be found. The lowest tuning-fork (16 v.d.) gives good results. The acuteness of the sense of hearing is about the same as in man under similar conditions, that is, when he is completely immersed in a large aquarium. Minnows can be trained to distinguish between different sounds, a feeding sound which means food, and a warning sound which means a punishment (a light blow with a glass rod). The best fish could distinguish perfectly the two sounds of a minor third (290 and 345 v.d.) in a long series of experiments. Fishes from which the utriculi, semicircular canals and ampullae have been removed have entirely lost the sense of equilibrium; nevertheless they can be trained to sounds as easily as normal fishes, in the same time, within the same limits, and the acuteness of the sense of hearing is the same as in normal fishes. The reactions of such fishes are especially impressive. When they are lying on the bottom of the aquarium and the whistle is blown, they rise very vigorously and swim through the aquarium turning somersaults again and again. Fishes with both lagenae and sacculi removed are fully in equilibrium; but it is impossible to train them to sounds higher than 130 v.d. To low sounds training is possible. The fish without sacculus and lagena can even distinguish between different sounds in the low region as well as normal ones. Therefore lagena or sacculus, or both, are the organs for the perception of middle high and high sounds. Whether the low sounds are perceived by means of the skin or the lateral line organ has not yet been definitely determined. All the reactions described here are shown in moving pictures during the lecture. These experiments, performed together with Dr. Stetter, are to be continued.

Action currents in the auditory nerve in response to acoustical stimulation; experiments demonstrating the correspondence between sound and nerve impulse: ERNEST GLEN WEVER and CHARLES W. BRAY (introduced by E. G. Conklin). By placing an electrode on the cat's auditory nerve near the medulla, with a grounded electrode elsewhere on the body, and leading the action currents through an amplifier to a telephone receiver, the writers have found that sound stimuli applied to the ear of the animal are reproduced in the receiver with great fidelity. Speech is easily understandable. Simple tones, as from tuning-forks, are received at frequencies which, so far as the observer can determine by ear, are identical with the original. Frequencies as high as 3,300 cycles per second are audible. Numerous checks have been used to guard against the possibility of artifact. No response was obtained when the active electrode was placed on any other tissue. After destruction by pithing of the cochlea on the electrode side, the intensity of the response was diminished; after destruction of the cochlea on the other side as well, the response ceased. The response ceased when the circulation to the head was restricted by pressing the vertebral arteries, and returned when normal circulation was restored. Likewise, the response ceased when a steady direct current was applied to the nerve, and returned when the direct current was removed. This result, that the frequency of impulses in the auditory nerve varies according to the frequency of the stimulus, does not bear out the expectation based upon the recent experiments on other sensory nerves, where it has been found that frequency of impulse varies according to intensity of stimulus. Moreover, the correspondence shown between sound and nerve impulse requires an abandonment, or at least an essential revision, of the modern formulation of the Helmholtz theory of audition.

Accumulation of electrolytes in valonia: W. J. V. Osterhout. Electrolytes often seem to contravene physical laws by diffusing against a gradient and reaching a greater concentration inside a living cell than outside. This seems to take place in the marine alga *Valonia macrophysa*, which forms large cells up to the size of a pigeon's egg. This may be accounted for (to a large extent at least) by the fact that the inside of the cell is more acid than the outside. A theory based on this has been successfully applied.

Compensating extrachromosomal types in Datura and their use as testers: A. F. Blakeslee, A. D. Bergner and A. G. Avery. A compensating chromosomal type is one in which parts from two different aberrant chromosomes compensate to form the equivalent in genic content of a whole normal chromosome. These two compensating chromosomes together, therefore, may replace a normal chromosome, and their non-compensating parts be left over as extra chromosomal material to cause morphological changes in the plant affected. Since in such compensating types each of the aberrant chromosomes contains parts from two different normal chromosomes, a chain of seven attached chromosomes is found at reduction. If a compensating type is crossed with pollen from a race derived by segmental interchange between any of the chromosomes involved in the two compensating chromosomes, then a chain of nine chromosomes results at reduction and all the normal sex cells of the hybrid will have the chromosomal constitution of the pollen parent. Thus, without cytological study, one can be certain of the chromosomal constitution of the offspring from such hybrids with compensating types. The use of such types has enabled us to demonstrate crossing over of genes between chromosomes in attached chains and to transfer genes from one chromosome to another without the necessity of chromosomal study. Methods for obtaining new compensating types have been developed. Thus in the offspring of a plant with a circle of six attached chromosomes, from one to three distinct compensating types should be expected, dependent upon the nature of the segmental interchange involved in the circle.

Incubation period of peach yellows as affected by point of inoculation: L. O. Kunkel (introduced by R. A. Harper). Those who have studied the transmission of peach yellows by budding and grafting report a long and variable incubation period for the disease. Smith found that the first symptoms usually appear from one to two years after trees are inoculated. The writer's experiments show that under ordinary greenhouse conditions the incubation period of yellows can be reduced to a minimum of about six weeks if vigorous young seedlings are used and the trees are inoculated at some distance above the ground level. Transmission is certain, and the incubation period shown by different individual trees is quite uniform in length under these conditions. The importance of inoculating trees above the ground level depends on the fact that the virus of peach yellows moves quickly down but rather slowly up the peach stem. It has been found to move down more than ten times as fast as it moves up. If inoculations are made at or very near the ground level, as is the case when trees are budded according to the usual nursery practice, the incubation period often extends over many months. The tops of such trees remain healthy for a long time because of the slow upward movement of the virus. A knowledge of the importance of the point of inoculation in determining the length and uniformity of the incubation period of peach yellows will greatly reduce the time and work necessary for testing various species of insects that are suspected of spreading this disease.

The character and causes of the extreme fluctuations in the abundance of the American mackerel: Oscar E. Sette (introduced by G. H. Parker). The remarkable fluctuations in the American mackerel fishery have long awaited a scientific explanation. During the last century the annual catch has been as large as 120,000,000 and as low as 4,000,000 pounds. During recent years, the annual yield has been between 30,000,000 and 50,000,000 pounds. Older theories ascribe the great changes in catch to variation in the availability of the mackerel to fishermen, but recent investigations by the U. S. Bureau of Fisheries have shown that variations are due almost entirely to actual changes in the number of mackerel in the sea. The reason for the great difference in the abundance of mackerel is that some spawning seasons fail to produce many mackerel while others are much more successful. When many mackerel result from spawning, the stock is built up and the sea is full of mackerel for the following years. When, on the other hand, there comes a series of years during which no new mackerel are added to the schools, the stock of older mackerel dwindles as the result of fishing and natural deaths, so that a period of scarcity sets in when the fishery suffers lean years until another good brood is hatched and grows to market size. The relatively large catches of recent years were due to the remarkable numbers of mackerel which resulted from the spawning of 1923, for this brood has accounted for three quarters of the commercial catch in the last five years. Other broods were virtually negligible, though those of 1921 and 1927 have contributed a few mackerel and the 1928 brood shows promise of making more substantial additions to the stock. Investigations on the spawning grounds have shown that the variable success of different broods does not depend as much on the number of eggs spawned as on the survival of the newly hatched young mackerel fry. Oceanographic work is now being carried on to determine what conditions in the sea cause high survival rate in some years and catastrophic mortality in others.

The bird life of Mt. Duida, Venezuela: FRANK M. CHAPMAN. Although it was discovered about 1750, Mt. Duida, near the headwaters of the Orinoco, Venezuela, was first ascended by an American Museum of Natural History expedition in 1928. It was found to be part of a hitherto unknown tableland of approximately 250 square miles in extent with an elevation of from 4,200 to 7,800 feet. The fauna and flora of this area was of the subtropical zone and composed in large part of new species, but with a marked affinity to the life heretofore known only from Mt. Roraima, 400 miles to the east. About one fourth the bird-life of this subtropical tableland has been derived from tropical ancestors still existing in the tropical zone at its base. These birds are usually larger and darker than those from which they have been derived and thus represent the influence on the organism of higher altitude and greater humidity acting under isolation. About one half the avifauna shows a more or less close resemblance to species occupying the corresponding life zone in the Andes, often at a distance of a thousand miles or more. The existence of these representative forms in such widely separated regions is explained by the theory that their common ancestors, or connecting forms, have disappeared from the intervening area. The remaining fourth of the avifauna is too distinct to afford evidence of its immediate ancestry and, it is possible, may be representative of the bird life of the great tableland of which Mt. Duida and Mt. Roraima are a surviving part.

The aerological results of the Greenland Expeditions of the University of Michigan: WM. H. HOBBS (introduced by John C. Merriam). The three Greenland Expeditions of the University of Michigan had for their primary object the study of the surface and upper-air currents near the border of the great ice-cap of Greenland—the glacial anticyclone. In 1926 a temporary base was established on the Maligiakfjord in latitude 66° 55′ north, 50 kilometers in from the sea and 100 kilometers distant from the inland-ice margin, where some 84 pilot balloon ascents were carried out. In 1927 a permanent station was established in an excellent position on Mt. Evans at the head of the Söndre Strömfjord. This station is in the same latitude as that of 1926, but is 120 kilometers from the coast and only about 30 kilometers distant from the edge of the inland ice. It was maintained in continuous operation for two full years. Pilot balloon ascents at Mt. Evans were made on all clear days, numbering 776, and were carried to an average altitude of 7,000 meters. Two exceptional runs on June 6 and August 6, 1928, were carried to altitudes of 29,000 and 27,000 meters respectively. This paper includes a summary discussion of results and a comparison of these with 35 balloon runs carried out by the Norwegian Meteorological Institute at Mygbukta in latitude 23° on the Greenland east coast.

A microscope-centrifuge (illustrated): E. NEWTON HARVEY and ALFRED L. LOOMIS (introduced by E. G. Conklin).

Certain scientific aspects of air transportation (illustrated): JOSEPH S. AMES.

Biographical memoir of John Trowbridge (to be read by title): EDWIN H. HALL.

Biographical memoir of Charles F. Chandler (to be read by title): MARSTON T. BOGERT.

Drop of potential and state of ionization near the cathode of a mercury arc: K. T. COMPTON and E. S. LAMAR. The exploring electrode method of Langmuir and Mott-Smith has been employed to investigate conditions in the region of the cathode of a mercury arc, supplementing a preliminary investigation by Killian (*Phys. Rev.* 31: 632, 1928). The cathode was designed so as to minimize the wandering of the cathode spot over the surface of the mercury. A movable exploring electrode was used whose thermal dissipating power was sufficiently great to prevent its melting while in the cathode region. The observations yielded values for space potential, the mean kinetic energy of the electrons and the electron concentration over distances ranging from .411 to 1.943 cm from the cathode. Space potential was found to be constant over this range and of value about 10 volts with respect to the cathode. If we allow a few tenths of a volt for contact differences in potential, then the indications are that the value of the cathode fall is quite near to the ionization potential of mercury. The assumption that in field free space the current is carried by diffusion of electrons permits estimates of the values of the electron mean free paths which are in fair agreement with those which would be expected from other experiments. The average energy of the electrons, in equivalent volts, is constant at 0.98 volt for distances between 0.8 and 2.0 cm from the cathode. At closer distances the average energy rises rapidly, being, for example, 1.3 volts at 0.51 cm and 1.7 volts at 0.38 cm. The electron and ion concentrations increase as the cathode is approached. Typical values are 0.34 $(10)^{12}$ electrons (or ions) per cm^3 at 1.94 cm, 1.5 $(10)^{12}$ at 0.79 cm and 2.9 $(10)^{12}$ at 0.44 cm. The reflection coefficient of the electrons at the surface of the tungsten collector is about 0.4. The above values are for 4.8 ampere arcs. If the current is increased to 11.0 amperes, the cathode drop is unchanged, the average energy of the electrons is slightly decreased and their concentration is increased at least ten fold. With the higher currents there is also a region of slightly reversed field just beyond the cathode fall space.

The "reaction-isochore" equation for ionization within metals: EDWIN H. HALL. In the relation

$$U = KT^2 \frac{d \ln K}{dT} \tag{1}$$

called by Nernst the "reaction-isochore" equation, U is the heat given out when a reversible isothermal reaction is carried on with the system maintained at constant volume, so that no external work is done. K is the "equilibrium constant" of the reaction, a quantity which does not change while the reaction is carried on isothermally. This equation has a firm thermodynamic foundation for reactions that can be reasonably conceived of as performed under certain conditions, first described by van 't Hoff. The author has long held that these conditions can not be conceived of as holding for the process of ionization within a solid metal, and he has therefore ignored equation (1) in his speculations concerning ionization, making certain hypotheses and reaching corresponding numerical conclusions without regard to any limitation imposed by this equation. He now finds that, for every one of the many metals studied, his numerical conclusions are consistent with an equation,

$$U = f \cdot KT^2 \frac{d\ln K}{dT} \qquad (2)$$

identical with equation (1) except for the presence of a numerical factor, f, in the second number. The value of f ranges from about 1.33 in nickel to about 3.13 in manganin, but for any one metal, though perhaps not entirely independent of temperature, it changes little if at all between 0° C. and 100° C.

Accommodation coefficients and heats of neutralization of gas ions at electrodes: K. T. COMPTON and C. C. VAN VOORHIS. When positive ions of a gas strike an electrode and become neutralized there are energy interchanges which result in heating of the electrode. Knowledge of this heating is important both in the interpretation of the physical phenomena which are involved and also in the practical design of gas discharge devices. With the aid of a thermocouple, and using this thermocouple as an exploring electrode in the ionized atmospheres of arcs at low gas pressures, we have studied the following factors which contribute to this heating: (1) the fraction of the incident kinetic energy of the ion which is delivered to the electrode (accommodation coefficient); (2) the fraction of the energy given to the ion by an applied electric field which is retained by the ion in spite of collision with gas molecules while approaching the electrode; (3) the portion of the apparent positive ion current to the electrode which is in reality due to electrons liberated from it under the influence of ultra-violet light, metastable atoms and positive ion impact; (4) the true "heat of neutralization" of the ion at the surface. The new and most important result of this work is the discovery that a considerable fraction of the kinetic energy of an impacting ion is retained after impact by the neutralized atom. The remaining fraction, which is delivered to the electrode as heat, is analogous to the "accommodation coefficient" which is recognized in the impact of ordinary gas molecules against a heated surface. In general these accommodation coefficients appear to approach unity for ions (or molecules) of high molecular weight. Our values are about 0.45, 0.7, 0.8 for ions of He, Ne and A, respectively. The existence of an accommodation coefficient less than unity, as thus proved by energy measurements, implies also that mechanical momentum is imparted by ions to electrodes in much larger extent than has hitherto been suspected. There are several observations on electrode arcs, which have been rather obscure, which seem thus to find a ready explanation. Of the four factors mentioned above as the objectives of our work, the first three are relatively so large in their effect that we have as yet been unable to arrive at definite conclusions regarding the fourth—the true heat of neutralization of an ion—whose determination would settle some interesting speculations regarding the mechanism of electric arcs.

The deformation of ions and the various types of chemical linkage: K. FAJANS (by invitation). One distinguishes usually two main types of chemical linkage, the polar or ionic and the non-polar or covalent linkage. The polar linkage is typified by the inorganic salts, such as sodium chloride; the non-polar linkage by the bond between the two atoms in the hydrogen molecule or by the linkage between the carbon atoms in the diamond and in organic compounds. According to the modern conception of atomic structure the ionic linkage in sodium chloride is produced by the transfer of one electron from the sodium atom to the chlorine atom. The electrostatic attraction between the resulting positively charged sodium ion and the negatively charged chlorine ion holds them together to form a molecule or a crystal lattice. In the non-polar linkage the two atoms are assumed to be joined together by a pair of electrons shared by both atoms, and revolving round their nuclei. Between these two main types of chemical linkage there exists a whole series of transition types. Beginning with the ideal ionic linkage these transition types can be understood as the result of the polarization (deformation) to various degrees, of the electron shell of the anion by the electric field of the cation. The degree of this deformation and consequently the deviation from the ionic linkage and the approach to the non-polar linkage is greater when the radius of the cation is smaller, its charge higher and when the deformability of the anion is greater. This approach to the non-polar linkage is also more pronounced for cations which do not show the rare-gas structure than for cations with this structure.

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THE UNIVERSE AS A WHOLE[1]

By Professor A. S. EVE

MCGILL UNIVERSITY

> In Nature's infinite book of secrecy
>   A little I can read
>
> —*Antony and Cleopatra*

THINKING COSMICALLY

MOST men to-day are engrossed in some one particular profession or occupation, that may involve monotonous drudgery, or may require special skill, technical knowledge, long experience and, more rarely, profound thought.

But it is doubtful if any group of men, except perhaps a few philosophers, is engaged in fitting together the jig-saw or patchwork puzzle of the multitudinous discoveries and theories of all our diverse branches of knowledge. Thought is thus divided into water-tight compartments, between which the communications are blocked.

Indeed, the further question arises whether the different parts of the puzzle will, in the present state of our knowledge, fit together at all; whether the gaps and misfits are not too wide and too great to permit of the undertaking. It is pertinent to remark that many of the great advances to-day are made by those who are fortunate and able enough to be expert in two subjects, for example, in physics and in physiology, or in mathematics and physics, or in physics and chemistry, or in physics and philosophy. Borderlands are prolific.

There is a further difficulty in finding a man with a sufficiently catholic taste to consider all the realms of knowledge as a unity. Who indeed is equipped mentally for such a giant's task? Who can say nowadays with Bacon that he "takes all knowledge for his province"?

Certainly not the present writer! The fitness rather rests with the audience, for the Royal Society of

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[1] Presidential address before the Royal Society of Canada, given on May 20, 1930.

Canada consists of men carefully selected for their achievements, as authors, poets, historians, statesmen and as savants of every branch of natural science, the very list of which it would be tedious to recite. These men, too, belong to at least two types of Western European civilization, crudely summarized as English and French, including our inheritance from Greece and from Rome.

Perhaps then we are justified in following the advice of Fitzgerald, "to think cosmically," and to contemplate the universe as a whole.

THE FRAMEWORK OF THE MACROCOSM

We find scattered through a vast region, nebulae, stars, planets, moons, comets, meteors, dust, gases and their radiations, with the main masses, the stars, far apart compared with their size, dominated by a mutual attraction, all in motion with respect to each other. There is there no such thing as rest. All these stars move with velocities ranging from a few miles a second to a few hundred miles a second. There is no suggestion of a very high gravitational potential; in simpler words, we see no evidence of an infinite, but rather of a large finite amount of matter in the universe.

Between these bodies there exists, or our intelligence infers from experience, a space approximately Euclidean, where the three angles of a triangle certainly do equal two right angles very nearly indeed.

This space has remarkable physical properties inasmuch as waves of a common nature pass swiftly in all directions freely, without interfering with one another's progress, differing, however, in wave-length, and all having the well-known high speed of light. This velocity appears to be one of the great constants of nature, which may be regarded not as relative, but as independent of the velocity of the source and of the speed of the observer. Space, then, is the region or vehicle of radiant energy. Since we know, or conjecture, that all matter is but one form of energy we can estimate energy in terms of mass, and we may even quote the price of radiant energy in pounds in place of kilowatt-hours, and calculate the quantity received by the earth from the sun. The price is high and the quantity large. The earth receives from the sun about 160 tons of sunlight a day, to a value of 500 million dollars a pound, so that our power bill amounts to 150 million million dollars a day, reckoned on the basis at which we have to buy our electricity in Montreal. This power bill is of course never presented, and our power-house, the sun, has been running effectively and regularly for at least ten thousand million years, and is likely to run, bar unforeseen accidents, for as many years at least in the future. We will postpone for the present the question of its closing-down!

This great space through which radiant energy passes may be regarded as empty or, inasmuch as it has the wonderful property of transmitting power, we may consider it as a physical entity, deem it worthy of a name and continue to call it ether, remembering always that in practice we give names to those things which have observable properties or distinguishable attributes. Apparently we must entirely divest our minds of all material ideas when we speak of the ether, but this will trouble us less and less as we continue to strip matter itself more and more of material attributes, and focus our attention on the less palpable manifestation of energy. Not that it is suggested that the word spiritual would at all help us in our idea of ether, nor can we find any warrant in fact, so far as present knowledge and experience seem to go, that the ether is the seat of psychic forces of a non-physical character. Any confusion between these ideas is at present the reverse of helpful, but even if the properties of the ether are one thing, and the properties of matter another, yet the linkage between them is so intimate that it may be that matter is merely a local singularity or peculiar structure of ether, as Sir Joseph Larmor and others have suggested.

At present it is still convenient to think of the universe as consisting, physically, of matter and of ether, or if you please, of two different forms of energy, matter and radiation alike passing through space.

SPACE

If, as is the fashion to-day, we are relativists, we can believe that our space is finite but unbounded, and we are at liberty to agree with Silberstein that no distance greater than nine million light-years is measurable in our universe. This leaves ample room for most of us, but it may be that some astronomers will feel themselves sadly cramped in so narrow a space, and indeed they now speak of distance exceeding a hundred million light-years.

To some degree it exalts the importance of each individual to realize that each one is the center of his own universe wherever he be, and however fast he may move. Every man has his own ether, just as every man has his own rainbow. All the signals of nature which we receive by our senses and interpret by our minds are of course different for each individual.

Speculations as to space and ether have a powerful fascination, but our actual knowledge is summed up by such ideas as Faraday's lines and fields of force, and more precisely by Maxwell's equations for electromagnetic fields. It was the effort to verify the truth of these equations which led Hertz to discover wireless (or radio) waves which enter to-day so largely into human life and experience.

THE MICROCOSM

As we find that the universe may be bounded in its size as regards greatness, so we may ask whether there is any limit in the other direction, whether there is any limit as to the possible smallness of an entity, and although the time is not yet ripe to speak definitely on this question, yet we shall see shortly that there may indeed be some limitation of the kind which I have suggested.

First let us, however, return to our suns, planets and moons, and realize that they are all made out of the same stuff, and of the very same elements with which we are familiar on this earth. This common material suggests, does it not, a very thorough mixing together in the past? The stars, each one of them, go through a regular prolonged stage of evolution, so that a glance at a star's spectrum, taken with telescope and prism, immediately informs the trained observer whether that star is in glorious growth, comfortable middle age or finally in the autumn of life or senile decay. Those stars which have reached their winter may be invisible to us, dark stars whose only chance, and that exceedingly remote, of a continuance of activity is a collision with a traveling neighbor.

The material of the universe everywhere consists of ninety-two elements, and it is now known that there remain only two or three to be discovered, unless there are some heavier than uranium. These elements are the bricks of which the great edifice is composed throughout. They exist rather permanently as atoms, except in one great group of radioactive atoms, which spontaneously disrupt and become new atoms. Some of the elemental atoms have also been deliberately broken up, by careful design, as when Rutherford knocked hydrogen nuclei out of nitrogen, using alpha particles of radium as his Big Bertha or Roaring Megs. This control of atoms and their behavior tells a very different story from the nineteenth century idea of hard, elastic, everlasting and indivisible atoms.

Atoms are wont to link together by bonds invisible and unknown (probably electromagnetic) and to combine into molecules, sometimes simple, and at other times, as in vegetables and animals, of appalling complexity. The simplest plant is a complex and marvelous chemical factory, which can also give birth to other similar factories! In the simpler cases it would at first appear probable that we could say—a molecule of water consists of two atoms of hydrogen and one atom of oxygen. We know the properties of both these constituent gases, therefore we can deduce the properties of the water molecule, and can foretell all the chemical and physical behavior of ice, water and steam. I need hardly tell you how immensely short we fall of this achievement at present, yet it is a perfectly reasonable goal towards which to strive. The matter is of such profound philosophical importance that it may be wise to dwell on it longer. The behavior of the hydrogen atom is well known, but is it possible to deduce the properties of the hydrogen molecule, which is two atoms in close partnership? Here we have the most direct and simple problem of physico-chemistry, and yet it turns out to be terribly complex; indeed men are spending a large part of their lives on such apparently simple problems. It seems that from two simple entities there is created, or there evolves, a quite new and different complex or entity. Surely there is some satisfaction to the biologists in this situation! We may use the dubious phrase "creative evolution," but the wonder is not that new forms arise; the larger mystery is how species are preserved, and how it is possible for offspring remotely to resemble their parents and ancestors!

To return to the molecules—after formation they are usually in a dynamic state, with their atoms oscillating to and fro, or revolving around one another, or both. The molecules may at the same time be rushing about with the velocity of bullets as in a gas, frequently colliding and rebounding, or they may jostle one another about in that crowded state we call a liquid, of which motion there is good evidence in the Brownian movement.

Yet again the molecules may, like men in a well-drilled army, fall into rank after rank of orderly arrangement so that there is a crystal, coherent, solid! The study of crystals has occupied, and is occupying, the lives of many of the ablest men in the world. In the great harmony of crystal arrangement there is to the human mind a satisfaction found elsewhere perhaps only in mathematics and in music.

ATOMS AND ELECTRONS

Hunting further in the microcosm we find physicists restless in the pursuit of the interior constitution of the atom. The genius of J. J. Thomson, Rutherford, Moseley, Bohr and others has drawn back the veil even in the lifetime of most of us, so that we find the bulk of the weight, mass or substance of an atom concentrated at the very nucleus or inner citadel, as a positive charge of electricity, this nucleus being small indeed compared with the whole atom. Around the nucleus we had a most satisfying picture or model of a swarm of electrons from one to ninety-two, according to the number of the atom, going swiftly around in elliptic orbits somewhat as planets go around our sun, with the most disconcerting added behavior that these electrons could leap from one orbit to another according to well-conceived plan or rule, totally at variance with all our previous knowledge of how well-ordered bodies should behave. Hence the great quantum theories which so greatly perturb old-fashioned physicists, who have to face a revolution in their electrodynamic conceptions when they endeavor to apply them to the constituent parts of an atom. It is curious to note that the principle of relativity has greatly attracted the attention of the thinking public, while the far greater *bouleversement* of quantum mechanics has hardly yet received attention.

At any rate, in place of the ninety-two elements in the universe, we enthrone two and only two physical entities—protons and electrons—together with the radiations or electromagnetic waves which pass through space between them, for every atom is both a wireless broadcasting station and also a wireless receiving station between which energy exchanges take place only in definite "lumps," each lump, bundle or quantum strictly proportional to the frequency transmitted; in other words, the illusive action is strictly atomic; or the ultimate "energy-time" is indivisible, a real atom. This sublimely simple electronic theory of the universe is now the fundamental common stock of all physicists, and provides sufficient and reasonable foundation for all purely physical phenomena. Yet it has been realized that the picture is too crude, and that there is either a limit to our perception or a limit set by nature herself, so that authorities like Bohr, Heisenberg, Schrödinger and Dirac assure us that we must abandon all models, all diagrams, all our large-scale experience, whether suns, planets or billiard balls, and admit that the microcosm does *not* resemble the macrocosm: that of the electron we can never say, Lo! here it is! It has gone before we say it. To mention its speed is to lose its position, or to indicate its place is to confound its speed. This is profoundly disconcerting to those, who, like the writer, have been brought up to revel in models and lines of force and diagrams. Only mathematical equations, complicated enough, expressing wave motions, can now describe the behavior of atoms and electrons. Only the probability can be calculated of the place or motion of individual electrons. The physicist stands as actuary calculating the statistical behavior of a crowded and confused entity. That there will be a reaction to these tendencies is most probable, perhaps led by plain-thinking Anglo-Saxons; but whether the reaction will be the more successful is quite another question. *Magna est veritas, praevalebit!*

Our satisfaction in the present physical outlook is further modified by two points. In the first place, we can not pretend to give any explanation of electricity or of electrical energy in terms of anything more simple or fundamental, so that there is still no bottom found to the deep well of truth. In the second place, when we are confronted with questions as to the origin and the enduring qualities of things we have no physical suggestion whatever, not the vaguest guess, to offer in reply. Two of the most important movements of to-day are these. The insistence that science must confine its attention to observable and measurable quantities, thus sharply separating physics from speculative metaphysics; and secondly the growing possibility that the search for the ultimate nature of substance is futile and, like perpetual motion machines, may be safely abandoned. Effort is concentrated on the structure, on the form, arrangement and resulting habits or behavior of things. Thus the appeal to models is passing away, and the trust in mathematical symbols, equations and deductions is growing stronger.

Personally I flatly rebel against all trammels and I advocate complete freedom in attacking all problems by any means available. When the key is lost, smash the lock and force the cupboard; and when the front stairs are blocked, try the back or a ladder outside. The work of many Anglo-Saxons has been of this direct and practical character, and it has proved singularly fruitful in face of difficulties. If Maxwell had been restrained, would his imaginative genius have produced his great treatise on electricity?

AGE OF THE UNIVERSE

There is clearly stamped on the universe a great but not an infinite antiquity. By all the known laws of physics the universe is a going concern, perhaps in middle age, which has not gone on forever and will not continue forever.

Two great tenets of science have been (1) the conservation of mass, the foundation of chemistry, and (2) the conservation of energy, the foundation of physics. It now appears probable, from the physics of the stars, that matter can cease to exist as such and give birth to a precisely equivalent amount of radiant energy. There is diligent search for the reciprocal transformation, whereby the continual outpourings of light and heat, radiating from all the stars and spreading into empty space, may again collect and reorganize into electrons, protons and atoms. No such changes are at present discernible.

Newton's queries in his "Optics" had some premonition of such energy changes:

> Are not gross Bodies and Light convertible into one another, and may not Bodies receive much of their Activity from the Particles of Light which enter into their composition?

> e events le of Bodies into Light and Light into Bo our liv comformable to the Course of Nature wh have n delighted with Transmutation.

ay this statement simply becomes, following in,

$$E = Mc^2$$

re E is the energy, M is the mass and c the great nstant, the velocity of light. By this equation we an express mass as energy, grams as ergs, or pounds as foot-pounds, or the converse.

It is not, however, the question of the annihilation of matter or the elimination of energy with which we are now concerned; rather it is the well-known fact that energy tends to become degraded or unavailable. All power machines and all life depend ultimately upon a source of heat relative to a cooler environment. Old age brings on that feebleness of energy which is no longer available when all has reached a dead level. There can not be water-power when the land is all at sea-level. Nor can you grind corn with water that has passed the mill! Unless indeed as now the beneficent rays of the sun, falling on the wide bosom of land and sea, lift again that water into the moving clouds to send a gracious rain on our inheritance. Many attempts have been made to remove this rather dismal picture of a worn-out universe from our imagination. Heat-death, it may be called.

The physical universe is proceeding, not to ruin, but to a dull uniformity. The energy will still be conserved, but it is becoming less and less available either for doing work or for sustaining life.

Had not Newton some conception of this question of the degradation of energy when he wrote the thirtieth query in his "Optics"?—"Motion is much more apt to be lost than to be got."

Jeans states that

> Everything points with overwhelming force to a definite event, or series of events, of creation at some time or times, not infinitely remote. . . . The universe can not have originated by chance out of its present ingredients, and neither can it always have been the same as now. For in either of these events no atoms would be left save such as are incapable of dissolving into radiation; there would be neither sunlight nor starlight, but only a cool glow of radiation uniformly diffused through space. This is, indeed, so far as present-day science can see, the final end towards which all creation moves, and at which it must at long last arrive.

Let us admit that "as far as present-day science can see" at the long last there are to remain some dead stars, some inert atoms and "the cool glow of radiation uniformly diffused through space," which must, of course, be perpetual, everlasting, devoid of change. But does anybody seriously believe that?

Jeans himself admits that everything points with overwhelming force to a definite event, or series of events, of *creation* at some time or times, not infinitely remote. Where there is creation, then there is purpose. Where there has once been purpose, there may be continuation of purpose, or a recurrence of purpose. So also if there was once creation there may be a continuance of creation or a fresh creation. Eliminate purpose and there is no creation and no beginning to the physical universe. At what stage then can purpose be eliminated? This question is not now popular, and the word "teleology," meaning purpose, or direction towards an end in view, is largely taboo in science to-day. But why?

This tendency of energy towards decadence was never more exquisitely stated than in the "Tempest," when Prospero, after showing his vision, exclaims:

> Those our actors,
> As I foretold you, were all spirits, and
> Are melted into air, into thin air:
> And, like the baseless fabric of this vision,
> The cloud-capp'd towers, the gorgeous palaces,
> The solemn temples, the great globe itself,
> Yea, all which it inherits, shall dissolve,
> And, like this insubstantial pageant faded,
> Leave not a rack behind. We are such stuff
> As dreams are made on; and our little life
> Is rounded with a sleep.

After which he begs us—

> Bear with my weakness; my old brain is troubled.

Well! Troy, Babylon, Carthage, have gone and we do not greatly lament them, and shall our turn not come? "Heraclitus is dead; and he was a better man than thou!"

Where we now are there was a sheet of ice perhaps four thousand feet thick. The ice will come again, and perchange go again, but ultimately it will remain.

And yet the full tide of pessimism has not been fathomed, for consider the words of Bertrand Russell in "Mysticism and Logic":

> That man is the product of causes which had no prevision of the end they were achieving; that his origin, his growth, his hopes and fears, his loves and his beliefs are but the outcome of accidental collocations of atoms; that no fire, no heroism, no intensity of thought and feeling can preserve an individual life beyond the grave; that all the labours of all the ages, all the devotion, all the inspiration, all the noonday brightness of human genius are destined to extinction in the vast death of the solar system, and that the whole temple of man's achievement must inevitably be buried beneath the debris of a universe in ruins—all these things, if not quite beyond dispute, are yet so nearly certain that no philosophy which rejects them can hope to stand.

Here indeed we have the very quintessence of ultra-pessimism. But as the man who tried to be a philosopher said to Dr. Johnson, "Cheerfulness will keep breaking through." Nobody need believe these things unless he likes; indeed we do not really know all this.

For another great philosopher, Whitehead, writes, "The fact of the religious vision and its history of persistent expansion is our one ground of optimism. Apart from it, human life is a flash of occasional enjoyment, lighting up a mass of pain and misery, a bagatelle of transient experience." But even this optimism has a decidedly neutral tint. The fact is that we are in a period of great flux and change, still under the shadow of the great war and its gloomy aftermath. It is the glory, the privilege and the responsibility of the present generations that they have immense new problems to solve. If we conform to the narrow limitations of a purely mechanical outlook, we shall never see the wood for the trees, and we shall reap as we sow. If the greater qualities are brought into play, then there may be success! What are these qualities? Dean Inge has compactly described them—"truthfulness, courage, justice and fair play, abhorrence of meanness and crooked dealing, and respect for all human beings as such."

The tendencies that we observe in a long period of time are really ephemeral; a fly, living but for a day, can not hope to detect the motion of the planet Neptune. It was a fly too in the fable, that, seated on a chariot wheel, exclaimed, "See! what a dust do I stir!"

Perhaps we should never say that at some distant date the universe was created; rather let us say, the universe is now being created, and insist that at all times such a statement has been true. Shall we add with Walt Whitman that the universe was never more perfect than it is now, and conclude with Marcus Aurelius, "Could he say of Athens, Thou lovely city of Cecrops, and shalt thou not say of the world, Thou lovely city of God?"

TIME

Like other entities time is a matter of experience. To the mathematician time is readily reversible, but in experience the past and the future are sharply distinguished. I can actually go to California and back, but not to last week and back, except in memory.

Yet if I go to California I must expend time to cover space; nor is my journey direct, but to right or left, and up and down, added to the actual distance, so that we have three degrees or types of space linked to one of time, and Minkowski brilliantly showed us how inevitably these were united in the four-fold union of space-time.

It has always seemed to me that even in this four-dimensional union something is still ıe first place, order to go to California I must have ntion of elec- portant fifth degree of freedom. It is vf anything however, that money is merely the opportunitstill no quire what we think that we need, and on a jıe sec money buys energy, so requisite for the travelerıs ase and movement, and no less essential to the arm we workers who to-day assist him on his journey whetlst by direct or mechanical means. A bird can obtain it energy directly from food, and requires no money for sustenance, clothes or transportation.

The fifth degree of freedom is, therefore, energy, and a large part of it we derive from breathing air, the only thing still free to all, without taxation or payment.

It is a remarkable fact that, in physics, energy has an intimate relation with time, and also with frequency; so that it is a particular fad of the author to endeavor to ascertain to what extent we can substitute the frequency of waves for the perhaps less tangible, but more familiar, concept of energy. This is scarcely the place to enlarge on this idea; and it must suffice to point out that, as Einstein explained gravitation on a geometrical basis, so it may be possible to consider energy more fully as an aspect of frequency, possibly arriving at a comprehensive wave theory of the universe.

Eddington in his "Nature of the Physical Universe" sets forth a fascinating picture of the inevitable unidirectional progress of time, as almost embedded in nature. The second law of thermodynamics, the running down of the universe as if it were a clock, with the gradual degradation and unavailability of energy, are picturesquely referred to as "time's arrow." The fact that certain processes in nature can not be reversed may lead to the result that time can not be reversed. To an intelligence higher than our own, time past, present and future might conceivably have a oneness quite foreign to our experience, but not perhaps beyond the imagination of a mathematician.

LIFE

So far we have considered matter apart from life. All the difficulties hitherto encountered become intensified by a new factor, which can not even be defined, when we consider living things. To suggest that life is merely mechanism is to confuse two terms with quite different meanings. Machines are contrived from without, but living things are organized from within, and we can not definitely demonstrate either conscious purpose or intelligent directing mind. Yet we do see the most marvelous coordination of the whole, due to the cooperation of the constituent parts. I am speaking of such things as trees and bees, and of many happenings within our own bodies. Were these events left to our conscious and intelligent selves, then our lives would not be prolonged for a minute. We have not intelligence enough to manage even a minute part of our bodies for a small fraction of a second. For example, who of us all would dare to assume complete responsibility for the output of new blood corpuscles, or for the necessary continual repairs, say, to his eye?

If a man breaks a leg, nature repairs it for him. Who and what is this nature?

> Nature is neither kernel nor husk—she is everything at once.
>
> —*Goethe*

> Nature is at once a *science* which never leaves off deducing effects from causes and an *art* which without end exercises itself in new inventions.
>
> —*Lachelier*

> Nature is now no more—even to the scientific thinker—a mechanical contrivance like a complicated and highly ingenious machine. . . . Nature is—what it always has been to the common sense view—a texture in which the mechanical warp is shot through everywhere by the spiritual woof.
>
> —*Merz, modified from William Jones*

That living creatures are constructed of matter no one will for a moment dispute; that there are, in life, transferences of energy which fully obey the laws of physics and chemistry no one will deny, but to insist that these laws or theories, as we now know them or even as they may develop, impose a necessary limitation to our conception of life, or to regard them even remotely as causation, is a step quite unwarrantable. What then do we need to add? There is nothing to suggest! But because no answer is at present forthcoming we can not assume that an answer is forever impossible. No doubt one important factor is the organization as a whole, which is not merely a sum of its parts.

The pretty quarrel between mechanists and vitalists and neovitalists is likely to continue with varied success on shifting battlefields. We can hardly be expected to settle the question this evening.

Let us, however, note three conclusions: Every form of matter comes from matter; every form of energy comes from energy; every living cell comes from a living cell.

The first two statements have already been shown to blend into one, so that matter may now be regarded as merely one form of energy. Nor need we doubt that life is also a form or manifestation of energy. What, then, is energy? Every schoolboy is ready with the answer, "Energy is the capacity for doing work." A mere translation! However, many schoolboys are capable of the more important step of actually measuring such work. Yet the definition reminds us of the gibe of Ruskin. "Why are the leaves of a tree green?" "Because they contain chlorophyll." "Then," he says, "you tell me that leaves are green because they contain green-leaf!" But truly, the situation is not as bad as it seems, inasmuch as man has now acquired so full a knowledge of what we may term the "habits of energy" that he can not only trace the interchanges of energy in nature, but he can also direct energy to his advantage and benefit. There is the enormous further achievement that energy is measurable by man and this is the first necessity for control. Hence there arise the multitudinous applications of mechanics and electricity which have invaded our lives in abundance and with such complexity, all depending upon known principles of physics. Indeed, we are rather intoxicated by these successes which leave the impression of far greater wisdom than perhaps we can justly claim, and we are apt to regard progress in mechanical and electrical contrivances as progress in civilization, which, of course, depends not only on material, but on intellectual, moral and spiritual values and qualifications.

ORIGIN OF LIFE

As to the origin of life, it remains, like the origin of matter, quite obscure. But the problem is not in the same category. To account for the origin of matter we have to regard it as arising from nothing; we have to consider energy proceeding from no energy, something quite outside our experience, and so unthinkable. It is not so when we consider the origin of life, where the material and the energy are both available. Hence there is speculation in the direction of highly complex molecules originating, step by step, from the simpler available molecules by the action of the ultra-violet rays of the sun. Some first fruits of chemical experiments in that direction have appeared. To be precise, sunlight has coaxed, so to speak, water and carbon dioxide to form formaldehyde. That step is truly a long way from the living cell. Rather vague terms are used to explain the further stages, such as surface tension and osmotic pressure, but my biological friends state that no "simple" cell is known to them. There is very great complexity in the simplest forms of life. Moreover, an eminent physiologist (Adrian) has stated:

> The nervous system is a mass of living cells which has the extraordinary property of appearing to influence, and to be influenced by, the mind. . . . It is a material system somehow responsible for such non-material things as emotions and thoughts. These are in a category outside the range of mechanical explanation, and for this reason the working of the nervous system will never be fully explainable in terms of physics and chemistry.

Again, Lord Balfour, writing as a philosopher, states, "No man can either perceive or imagine the mode in which physiological changes give birth to psychical experiences."

Most of us will concur with these verdicts, but we must remember that there is a more daring school who repudiate these limitations, due, they say, to the present imperfect state of our knowledge.

If the organic rose from the inorganic, then there is the first stage of the stupendous developments of life, both in number and in type, which surround us on this wonderful planet. Certainly a single fiat of creation has, in most thinking minds, given way to the more glorious conception of the perpetual creation which surrounds us. To-day is created anew from yesterday. One second gives birth to a fresh and different succeeding second, and yet between them an enduring linkage occurs. While it is not difficult to coin phrases to describe and summarize this remarkable development, and perhaps the term creative evolution is the most helpful, yet we must use it merely as a label or description, and avoid the common blunder of confusing a name with a cause.

Somehow in the human frame the front legs have become arms, and the front feet, hands, while one digit on each hand has become a thumb. The young child crawling on all fours as a little quadruped painfully and with repeated practice raises himself on his hind legs and learns to walk. Only the anatomists and physiologists are fully aware of the intricate coordinations which these efforts, conscious and unconscious, demand on the brain, nerve and muscle. Does the young child herein repeat a part of the story of the race, of its ancestry? Indeed, it has been stated that "every bone and every muscle of man's body have undergone profound structural alterations to fit him to his orthograd posture."

Certainly repeated struggles and strivings are necessary for the preservation and development of every form of life, while disuse leads towards annihilation; but these sage reflections, which may briefly summarize an observable process, leave all the most fundamental questions unanswered.

The highest development perceived or known in the universe is found in the intelligence and soul of man. Just as the properties of space have given rise to the rather vague term, ether, as a term indicative of properties and happenings, so such words as mind and soul are convenient summaries for unquestionable attributes.

It is somewhat strange to think that if the whole human species were submerged in Lake Ontario the water would rise but a few inches, and doubtless the universe as a whole would go forward but slightly affected, and dynamically and materially unimpaired. There was such a time, perhaps less than ten thousand million years ago, when there was no life on this earth; there will be such a time perhaps a hundred thousand million years hence when life on the earth will have passed away. Few will dispute the calculation of Harold Jeffreys that in a million million years all the waters of the ocean will have frozen to the very bottom and all the land be covered with ice and snow. Go, however, into one of our great libraries and you will find that the majority of books deal with man and his history and achievements. Why this importance attached to man? Do we flatter ourselves? Can we be just super-monkeys traveling on a speck of a planet going round a commonplace sun?

This pessimistic suggestion stands in sharp and dark contrast with the idea that this world is a training ground for immortal spirits. The view of Professor A. N. Whitehead may prevail that though the universe is physically descending, yet it is spiritually ascending.

PHYSICAL FIELDS

In order to further an attempt to approach a general view of the universe it is desirable to return for a while to the ideas of Faraday and to contemplate what he termed fields of force, or, as we might say, domains of energy. In a notable sentence he writes:

> The view now stated of the constitution of matter would seem to involve necessarily the conclusion that matter fills all space, or, at least, all space to which gravitation extends (including the sun and its system); for gravitation is a property of matter dependent on a certain force, and it is this force which constitutes the matter. In that view, matter is not merely mutually penetrable, but each atom extends, so to say, throughout the whole of the solar system, yet always retaining its own center of force.

It is probable that Einstein could modify this statement so as to cover his theory of gravitation where a geometrical field is caused or modified throughout space, so as to account for the motion of the heavenly bodies without the "forces" of which Newton conceived and about which Faraday was writing.

The word "field" has a wide use in the English language, such as hayfield, battlefield and so forth. In every case it denotes an area or region of events or happenings. Its introduction into physics has been fruitful. Near the earth, matter falls towards the earth in straight lines or curves and we can explore the laws or habits of material objects in this gravitational field. Newton extended this localized field from the earth outwards to the moon and throughout the solar system. To-day the field is extended to include the motion of the double stars.

Around the earth there is also a magnetic field wherein a compass needle takes a definite direction. So also an electrically charged body is surrounded by an electrical field. At the present time we are immersed in an electromagnetic field, witness these rays of light perceived by our eyes, and the radio or wireless waves which now at all times penetrate even through our homes and very bodies. Attention should be directed to the important fact that there may be complete overlapping of fields. At one and the same place gravitational, electric and magnetic fields coexist. Hence the efforts of Einstein and of Eddington to get one, and only one, "field" which will give a full description of all gravitational and electromagnetic events.

Three things are essential for perception: the source or broadcasting station; the receiver, which must be duly tuned to the source, and the transfer of energy through space. Thus the atoms in the sun broadcast light to us, but we perceive with our eyes only those rays to which our eyes are tuned—that visible octave which is but a fraction of the great spectrum of total radiation.

The importance of correct tuning is now well understood in radio reception, as in all electromagnetic fields, but it is desirable to realize its wider applications. Conversation in the ordinary sense is not possible either by the dumb or to the deaf. The one lacks the transmitting power of speech, the other the receptive power of hearing. Now there are also mental or intellectual fields where a thinker has ideas which he wishes to convey by speech or writing to other intelligences who are willing to understand and receive them. Who can overemphasize the importance not only of intellectual capacity, but also of sympathetic tuning in all mental fields, wherein again form, structure and style are nearly as important as subject or substance?

No less is this true in all forms of art. It is the glory of the artist to create an artistic field. Appreciation of this field by the observer or recipients again depends on the receptivity both as regards capacity, and quality or value. In mental and artistic fields all the precision of mathematical physics is lacking. Measurable quantities are entirely absent. Judgment, good sense and experience are the sole guides of value. But there is beyond all this, indefinable and precious, that inspiration and genius which persuade us that there is something more and something greater than we can include and define in purely physical fields. Yet if we are going to chop up the universe into wholly independent regions, we at once lose that simplicity and generality which it is our hope and ambition to achieve. It is believed that when conflict arises between two domains of thought, for example, religion and science, the reason for such conflict resides in our limited knowledge and intelligence. When conflicts occur in nature, readjustment necessarily and inevitably corrects them.

Greatest of all are those fields where the spirit of man is tuned to the spirit of the universe, so that man is, as it were, a god, or is in complete communion with God.

Are these ideas idle dreams or fantastic visions? No! We can claim as much reality for spiritual fields as for mental, artistic or physical fields. "By their fruits ye shall know them!" Here indeed may be the secret of secrets! The direct evidence of spiritual fields is found in the attributes and experience of those who, finding themselves *en rapport* with the divine light, bear testimony, by their lives, by their actions, by their thoughts, by their influence, that the inner light guided by reason is no mere illusion or dream.

I choose two illustrations. Mr. Baldwin, politician and statesman, lately premier of England, states:

> For myself I say that if I did not feel that our work and the work of all others who hold the same faith and ideals, whether in politics or civic work, was done in the faith and the hope that some day, maybe a million years hence, the kingdom of God would spread over the whole world, then I would have no hope, I could do no more work and I would give my office over this morning to any one who would take it.

These words of Mr. Baldwin's evoke admiration and awake an echo in our souls. And yet—there is a stage even more noble, where those who feel that they are playing a losing game or know that they are fighting a hopeless battle persevere in their undaunted quest for the truth, which includes all that is good and beautiful, persevere in scorn of consequence.

Yet one more witness by a woman, who, in face of disappointments, ill health and approaching death, wrote that fine swan-song, "No coward soul am I!" concluding with her life's vision:

With wide embracing love
Thy Spirit animates eternal years
Pervades and broods above
Changes, sustains, dissolves, creates and rears
Though earth and man were gone
And suns and universes ceased to be
And thou wert left alone
Every existence would exist in Thee.

—*The last poem of Emily Brontë*

OBITUARY

WILLIAM HENRY NICHOLS

Dr. William H. Nichols, past president of the American Chemical Society and widely known as a leader in chemical industry, died at Honolulu, Hawaii, on February 21, after a brief illness. He was born in Brooklyn, N. Y., on January 9, 1852, attended the Brooklyn Polytechnic Institute for two years and completed his college course at New York University, from which he graduated in 1870. His later collegiate degrees included the M.S. from New York University in 1870, the LL.D. from Lafayette in 1904 and from New York University in 1920, and the Sc.D. from Columbia in 1904, from Pittsburgh in 1920 and from Tufts in 1921. His choice of chemistry as a career was the result of the influence of John William Draper, under whom he studied at New York University.

Dr. Nichols's career in the field of industrial chemistry began in 1870, when he started a small manufacturing business in which because he had not yet reached his majority he was obliged to use the name of his father in the firm name. The growth of his interests is not merely a parallel to that of the chemical industry during the sixty years which followed, but is itself a significant part of the industry. The Nichols Chemical Company, the Nichols Copper Company, the Benzol Products Company, the National Aniline and Chemical Company and most recently the Allied Chemical and Dye Corporation represent progressive growth in magnitude of enterprise and in value of products, the latter company being one of the largest chemical corporations in this country. These growths were accomplished not solely by business enterprise but also by discoveries of a fundamental character in the industry, such as the first American usage of iron pyrites in the manufacture of sulphuric acid, the first production of electrolytically purified copper for commercial use and the adaptation to American conditions of the synthesis of ammonia from nitrogen and hydrogen, which his company had worked out on an experimental scale as early as January, 1914, before the outbreak of the World War.

Dr. Nichols was one of the organizers of the American Chemical Society in 1876 and was its president in 1918 and 1919. He was president of the Society of Chemical Industry in 1904–05, and chairman of the Eighth International Congress of Applied Chemistry, held in New York City in 1912. His service to collegiate education included membership on the governing boards of the Brooklyn Polytechnic Institute and of New York University for a considerable period of years; he acted as vice-chairman for the former institution and for the latter as vice-president of the council and for a period as acting chancellor. Throughout these years he was a generous contributor also to the financial needs of both colleges, his gifts including among others the Nichols Laboratory of Chemistry at New York University, completed in 1927 at a cost of $700,000. His will included a large number of charitable bequests to various religious organizations, to the American Chemical Society, to the Brooklyn Polytechnic Institute and a residuary legacy to New York University estimated at a value of about two million dollars.

Arthur E. Hill

New York University,
May 5, 1930

J. ARTHUR HARRIS[1]

The real scientist must have interest in his chosen field of knowledge and a belief in the importance of that field. To this he must add a broad conception of its scope and limitations, ability to distinguish between the essential and the unessential, and diligence in examining every scrap of evidence which bears on the subjects within his field. All of these characteristics J. Arthur Harris possessed in unusual degree. His industry was untiring. He had no schedule of working hours when a problem was to be solved. Nothing was too insignificant for serious consideration and nothing too important to escape investigation. With this was a broad-minded consideration for the views of others, even though opposed to his own, and a keen scientific interest in attempting to see to what extent they would add to his own knowledge of the subjects under discussion. These qualities brought him wide recognition not only within the institutions with which he was associated, but throughout the country and far beyond.

A distinguished student of Karl Pearson, he was a pioneer in the introduction of the biometric method in the domain of botany and in biological science in general. His accomplishments in this field included both the application of quantitative methods to the study of living things and also fundamental contributions to the logic and theory of scientific method. In recognition of these attainments he received in 1921 the Weldon Medal and Memorial Prize of the University of Oxford, the highest award of merit in this field of science.

The laurels which he earned in the field of biometry would suffice for most men but not for him. In the field of ecology he blazed new trails, brought in new conceptions, new quantitative technic, and adapted the study of the newer science of physical chemistry to his pioneer field studies in plant geography. He believed in studying plants in their own environment, and he carried his paths through the morasses of the Dismal Swamp and the Everglades, through the montane rain-forests of Jamaica and Hawaii and through the deserts of Jamaica, Arizona and Utah. He bore personally much of the expense of such field studies, and the advancement of science was the only reward he claimed.

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[1] Resolutions adopted by the faculty of the College of Science, Literature and the Arts, the University of Minnesota, April 28, 1930.

In 1924 he came to the University of Minnesota. With remarkable rapidity he won the admiration and love of his colleagues and the advanced students. He was a great teacher, broadly trained, earnest and sympathetic. At his feet sat the students from nearly all of the various fields of science represented in our university. They acknowledged him as master—they were proud to call him friend.

It was not only in the laboratory, in the field and the classroom that Dr. Harris was eminent. He possessed administrative gifts to a high degree. Official routine was not pleasant to him and he did not consider it a matter to be regarded too seriously if the desired results could be legitimately obtained through short cuts. In his relations with his colleagues, both within his department and without, he was always a gentleman, careful to observe the amenities in every way and to make the work of others easier, while his own efforts were being directed to greater efficiency within his own department. He was generous in recognition of the abilities of his colleagues and he exerted himself to the utmost to secure for them congenial working conditions. It was his ambition, only partly realized on account of his untimely death, to make the University of Minnesota a widely known institution of recognized merit for biological research. The laboratory, the herbarium and the library were all objects of his deepest interest as auxiliaries to this main object.

He was not only a scientist of note and an executive who obtained results, but a congenial companion as well. He was at home in any circle. His wide interest in things outside his own field was acute, his sense of humor prevented him from becoming one-sided or narrow. His genuinely tolerant attitude made it easy to discuss with him things which in most circles would be matters of controversy. In his passing, the University of Minnesota has lost one who can never be replaced as scientist, administrator and friend.

Prepared by the Committee
Royal N. Chapman
Ross Aiken Gortner
Richard E. Scammon
Frank K. Walter
C. Otto Rosendahl, *Chairman*

RECENT DEATHS

Dr. Thomas E. McKinney, from 1908 to 1928 professor of mathematics in the University of South Dakota, died on April 14, aged sixty-six years.

Dr. L. J. Weinstein, who recently was appointed professor of metallurgy at Northwestern University, died on May 14 at the age of forty-nine years.

Dr. Ernest Clement Angst, assistant professor of botany and bacteriology at the University of Oklahoma, died on April 18.

Dr. Grace Barkley, assistant professor of botany in DePauw University, died on April 1, from cerebral hemorrhage resulting from a fall. Her principal contribution was a cytological study of the origin of the spiral markings of protoxylem.

Dr. George Dimmock, of Springfield, Mass., known for his contributions to entomology, died on May 17, his seventy-eighth birthday.

Dr. Fridtjof Nansen, distinguished as explorer, man of science and statesman, died on May 13.

MEMORIALS

A memorial meeting to the late Arthur M. Miller, for thirty-five years professor of geology at the University of Kentucky, will be held on May 30 at his home "Maxwelton," which Professor Miller gave to the university several years ago. The chief speaker at the meeting will be Dr. Collier Cobb, professor of geology at the University of North Carolina, who was associated with Professor Miller for 40 years, consulting with him as late as 1928 in the drawing up of a new geological map for North Carolina. Dr. Austin R. Middleton, zoologist and biologist of the University of Louisville, will officially represent the Science League of America. Dr. W. D. Funkhouser, dean of the Graduate School of the University of Kentucky, will speak of Professor Miller's work. James H. Gardner, president of the Gardner Petroleum Company of Tulsa, Okla., an alumnus of the University of Kentucky, Rolla R. Ramsey, professor of physics at the University of Indiana, and Dr. Walter H. Reynolds, Presbyterian minister at Liberty, Ind., are also on the program. Dr. W. R. Jillson, state geologist, will preside at the meeting.

In memory of the late Sir Baldwin Spencer, who was professor of zoology in the University of Melbourne, it has been decided to place a bronze medallion in the zoology library in the university. Mr. Paul Montford has been commissioned to prepare this medallion, and old students of Sir Baldwin Spencer are invited to contribute towards the cost, which will be a hundred guineas. Donations should be sent to Sir Thomas Lyle, Lisbuoy, Irving Road, Toorak, S.E.2, Victoria, Australia.

The council of the University of Manchester has accepted a bronze plaque of the late Professor W. H. Perkin from a number of his former students and friends, and it will be unveiled in the Chemistry Theater on May 24.

SCIENTIFIC EVENTS

THE AMERICAN ENGINEERING COUNCIL AND AVIATION

ENGINEERS throughout the United States, as represented in the thirty national and local organizations forming the American Engineering Council, have formally placed themselves at the service of the nation's commercial aviation for the solution of basic technical, operating and safety problems now affecting the industry.

This action, taken through the administrative board of the council, in effect enlists 60,000 technical men in all phases of engineering as a consulting body for the promotion of commercial flying.

Formulation of fundamental principles which will serve as a guide in the selection, design and operation of airports and airways and a large program of research to develop safer and more efficient airports and operation methods are among the first tasks proposed by the council, the president of which is Dr. Carl E. Grunsky, of San Francisco.

The results of this work will be disseminated through the Bureau of Aeronautics of the U. S. Department of Commerce as the logical clearing house for such information. By this system the council plans to make its findings available at once to all technical men engaged in aviation problems.

On the ground that it is "the clear duty of the professional engineers of the United States to assist in the development of sound engineering and economic principles" for American aeronautics, the council has acted on a report of its committee on airports, of which Professor Ralph J. Fogg, head of the Department of Civil Engineering in Lehigh University, is chairman. The committee, having come to a decision as a result of its study, has made the following recommendations:

1. That American Engineering Council, as an organization dedicated to the service of the community, state and nation, and as representative of all phases of engineering, become actively interested in the broad engineering and managerial aspects of commercial aviation, and particularly airports.
2. That American Engineering Council wholeheartedly cooperate with the Bureau of Aeronautics of the Department of Commerce in such joint efforts as it may undertake in formulating and disseminating general principles relating to commercial aviation for the guidance of the public.
3. That American Engineering Council create at once a general committee on commercial aviation, with the addition of such sub-committees as may be necessary from time to time, to make a complete study of all aspects of the engineering problems involved.
4. That American Engineering Council adopt the policy, in its cooperation with the Bureau of Aeronautics, of having the sub-committees act on invitation as the council's representative on joint committees.
5. That American Engineering Council accept the invitation received from the Bureau of Aeronautics to join in a cooperative study of the coverage and drainage of airports.
6. That there be organized at once a sub-committee to participate in the joint study of airport coverage and drainage.

Other members of the council's committee on airports are: Perry A. Fellows, city engineer, Detroit; W. W. Horner, chief engineer, St. Louis; Dr. Harrison E. Howe, editor, *Industrial and Engineering Chemistry*, Washington; Alexander Klemin, head of the Guggenheim School of Aeronautics, New York University; H. G. Shirley, commissioner of highways, Richmond, Va.

STATE APPROPRIATIONS FOR CORNELL UNIVERSITY

THE New York State Legislature, recently adjourned, made appropriations for a number of important expansions or new activities for the State Colleges and Experiment Stations at Cornell University. Among the more significant of these was an appropriation of $510,000 to be used with an appropriation of $485,000 made by the legislature of the preceding year for the erection of a new building for the work in home economics; authorization to enter contracts for a new building for agricultural economics and rural social organization at a cost of $650,000, and an appropriation of $285,000 for a new horticultural research laboratory at the State Experiment Station at Geneva. A grant of $400,000 was made for the equipment of the plant science building now nearing completion, which will cost $1,000,000. In addition to these major items the regular budget of the College of Agriculture was increased by $82,020 and there were incorporated as permanent funds $51,050 of special grants made for animal husbandry developments the year preceding.

The following special items were also appropriated: Construction of barns and facilities for animal husbandry, $100,000; purchase of additional land for animal husbandry purposes, $60,000; office and laboratory building at Long Island Vegetable Research Farm, $13,000; addition to tool shed for Long Island Vegetable Research Farm, $1,000; grading, walks, roads, etc., for plant science building, $15,000; investigations for control of Oriental peach moth, apple maggot, etc., by the State Experiment Station at Geneva, $37,000; for the survey of agricultural resources of the state $20,000; for investigation in the spraying and dusting of potatoes on Long Island, $16,500; for extension work in potato growing, $5,500; for investigation in grading and handling of vegetable crops, $5,800; for investigation in control of insects affecting muck soil crops, $6,010; for investigation in control of insects affecting potatoes, $4,000; for an experiment to determine the optimum percentage of protein in a dairy ration, $5,900; for equipment and maintenance of The Western New York Egg Laying Contest, $30,000; for equipment and maintenance of The Central New York Egg Laying Contest, $30,000; for additional state support of County Farm and Home Bureaus and Junior Extension Work, $40,500.

Another legislative enactment of outstanding importance to the State Colleges at Cornell University was a bill admitting all of the staff and employees of these institutions to the privileges of the State Retirement System. Because of the generous character of this system, this provision is considered to be a distinct benefit by members of the staff.

THE UNIVERSITY OF MEXICO AND DR. HOLLAND

DR. W. J. HOLLAND, on May 2, 1930, completed the installation of a replica of the skeleton of *Diplodocus carnegiei* donated by Mrs. Andrew Carnegie through the Carnegie Corporation of New York and the Carnegie Museum of Pittsburgh to the National Museum of Natural History in Mexico City. Dr. Holland had with him as his chief mechanical assistant Mr. Louis S. Coggeshall, of the section of paleontology in the Carnegie Museum.

On the morning of May 2 a convocation of the trustees and faculty of the National University of Mexico was held in the Casa del Lago in Chapultepec Park, the rector of the university, Señor Dr. Ignacio García Téllez, presiding, supported by Professor Dr. Isaac Ochoterena, the director of the Natural History Museum, and president of the Instituto de Biologia. The rector of the university at the commencement of the meeting announced that the University of Mexico by the action of its duly constituted authorities had made Dr. Holland "Professor Extraordinario de Biologia," and handed Dr. Holland a diploma to that effect. The position is purely honorary and has only been conferred a few times upon distinguished men of science in Europe and Mexico.

In response to the address of the rector Dr. Holland said that he was acting as "the unofficial ambassador of one of the queens of American society, whose husband, the late Andrew Carnegie, had shown in more than royal manner his desire for the establishment of cordial and everlastingly pacific relations between all nations of the Western Hemisphere through his gift to the Pan American Union of a palatial home in Washington." He dwelt upon the important part which men of science may take in promoting a good understanding among the nations. He said that, "while in the past men who bear arms by sea and land had been relied upon to preserve peace, he hoped the day is not far off when men whose weapons are the microscope, the telescope, and the chemist's retort, may prove their superiority to lethal weapons." He concluded by expressing his deep interest in the scientific researches which are now being carried on in Mexico by men whose methods and spirit are thoroughly abreast of modern times.

HONORS CONFERRED BY THE FRANKLIN INSTITUTE

AT the Medal Day exercises of the Franklin Institute, held on May 21 in the hall of the institute, the following honors were conferred:

Honorary membership was bestowed upon Dr. M. E. Cooley, dean emeritus of engineering of the University of Michigan, in recognition of inspiring guidance in engineering education, and of friendly reasonableness, enlightened judgment and fearless integrity in the principles of his profession. Dean Cooley had been a professor of mechanical engineering since 1881 and dean of the College of Engineering, University of Michigan, since 1904.

Dr. Henry Leffman, retired chemist, also received honorary membership, in recognition of valuable services to science in research, in teaching, as former port physician of the City of Philadelphia and as a discriminating but good-tempered critic.

A Certificate of Merit was presented to Mr. Heyman Rosenberg, Parker-Kalon Corporation of New York City, in consideration of the successful modification of screws, consisting of hardening the threads, thus permitting them to thread their own way when driven or turned into the material to be joined, and the invention whereby the diameter of the body at the base of the thread is less than that of the cylindrical end.

Edward Longstreth Medal—founded in 1890 by Edward Longstreth, Philadelphia.

Mr. Ervin George Bailey, president of the Fuller-Lehigh Company, Fullerton, Pennsylvania, in consideration of his invention and development of regulating and controlling devices and measuring and recording instruments.

Professor Charles Weyl, University of Pennsylvania, in consideration of the ingenious adaptation of mechanical and electrical principles to the operation of an X-ray apparatus which has proved useful in the diagnosis of certain diseases in their early stages of development.

John Price Wetherill Medal—founded in 1925 by the family of the late John Price Wetherill.

Mr. C. S. Chrisman, formerly with the United Gas Improvement Company and now retired, of West Chester, Pennsylvania, in consideration of his ingenious and economical improvements in the apparatus for, and methods of, gas manufacture.

Mr. W. N. Jennings, business photographer, Philadelphia, in consideration of his pioneer work in the photography of flashes of lightning.

Walton Clark Medal—founded in 1926 by the United Gas Improvement Company, in honor of Dr. Walton Clark, former chief engineer of that company and for many years president of the Franklin Institute.

Mr. Henry L. Doherty, president of the Cities Service Company, New York City, in consideration of his outstanding and valuable work in the development of the manufactured gas industry.

George R. Henderson Medal—founded in 1924 by Mrs. Virginia P. C. Henderson, in memory of her husband, a consulting engineer in Philadelphia and a member of the Board of Managers of the Franklin Institute.

Mr. George Hannauer and Mr. Edgar M. Wilcox, jointly, in consideration of the development of the Car Retarder System and contributions to railway engineering. The work for which the medals are awarded was done jointly by these two gentlemen. Unhappily, Mr. George Hannauer died before the award was completed. Mr. Wilcox, secretary of the Hannauer Car Retarder Company, of Gibson, Indiana, will be present to receive his medal in person, while the late Mr. Hannauer will be represented by his son.

Louis Edward Levy Medal—founded in 1923 by the family of Louis E. Levy, of Philadelphia. Mr. Levy was a member of the institute's Committee on Science and Arts, and vice-president of the institute. He was an inventor and photoengraver.

Professor Floyd K. Richtmyer, department of physics, Cornell University, because of the excellence of his paper which appeared in the *Journal* of the Franklin Institute in September, 1929, entitled, "Some Secondary Phenomena in X-ray Spectra."

Elliott Cresson Medal—founded in 1848 by Mr. Elliott Cresson, who was very much interested in the work of the Franklin Institute. This award is very highly prized and is next to the Franklin Medal in importance.

Mr. Norman Rothwell Gibson, vice-president and chief engineer of the Niagara Falls Power Company, in consideration of his originality in first adapting a well-known law of mechanics to the measurement of flowing water, his skill and ingenuity in developing apparatus for accurately recording the required data, the simplicity, accuracy and economy of his method, the wide scope of its application in measuring the flow of liquids and its very general adaptation in commercial work.

Mr. Irving Edwin Moultrop, chief engineer, the Edison Illuminating Company of Boston, in consideration of the engineering skill displayed in the design and construction of the high-pressure installation of the Edgar Station, whereby a marked advance in the art of steam electric generation was accomplished and a reliable source of information for advance predication, not only of performance but of initial cost of such stations, was made available, and in which courage of high order was manifested.

Franklin Medal—founded in 1914 by Samuel Insull, Esq., of Chicago, to be awarded to those workers in physical science or technology, without regard to country, whose efforts, in the opinion of the institute, acting through its Committee on Science and the Arts, have done most to advance a knowledge of physical science or its applications.

Dr. John Frank Stevens, retired engineer, former chief engineer, the Panama Canal, in recognition of his unifying solutions of widely varying and difficult engineering problems met in the planning of the great Panama Canal, of the marked power shown by him in the organization of the engineering forces which later built that canal and of his eminent success in the location, construction and administration of railroads in this country and in foreign lands.

Sir William Bragg, director, the Royal Institution of Great Britain, London, in recognition of a life work in the study of X-rays and radioactivity, in the course of which he made fundamental contributions to that realm of physics, of his development of a method of determining molecular and crystal structure by the reflection of X-rays and of his fruitful guidance of the Davy-Faraday Research Laboratory and the Royal Institution of Great Britain.

Immediately after the presentation of the medals, D . John Frank Stevens read a paper entitled, "A Momentous Hour at Panama," in which he recounted some hitherto unpublished happenings in the building of the canal. Sir William H. Bragg delivered a paper on "The Meaning of the Crystal," a short article based upon his own researches of the meaning of the crystal in nature. On the evening of Medal Day, the Franklin Institute had as its guests of honor the medalists of the day at a dinner held at the Bellevue-Stratford.

Following his appearance in Philadelphia, and under the auspices of the Franklin Institute, Sir William H. Bragg will deliver a series of three lectures, based upon his own important work and discoveries in the realm of physics. He will speak at Columbia University, Johns Hopkins and Princeton. He will also be the guest of honor at a colloquium to be held at the Bartol Research Foundation Laboratory of the institute. Sir William will also broadcast over WCAU on the afternoon of Thursday, May 29. He plans to remain in this country for several weeks, attending various scientific meetings. He will be accompanied by his daughter.

SCIENTIFIC NOTES AND NEWS

A LUNCHEON in honor of Dr. A. E. Kennelly, professor of electrical engineering at Harvard University, was recently given at the Harvard Club of Boston to mark the completion of twenty-eight years of service to the university. Dr. Kennelly is retiring from active service at the end of the present academic year. A silver loving-cup, suitably inscribed, was presented to him by his colleagues in the Harvard Engineering School. Brief remarks were made by President A. Lawrence Lowell and by Dr. Kennelly.

THE Willard Gibbs Medal of the Chicago section of the American Chemical Society will be presented to Dr. Irving Langmuir following a dinner to be given in the Palmer House, Chicago, on the evening of May 23. Dr. Langmuir's address will be on "What are Atoms Like?—How do We Know?" He will be followed by Dr. Karl T. Compton, of Princeton University, president-elect of the Massachusetts Institute of Technology. Shorter addresses will be made by President Glenn Frank, of the University of Wisconsin; Dean R. E. Heilman, of Northwestern University; Dr. Herman Bundesen, coroner of Cook County, Illinois, and Mr. Martin Insull, of the Midwest Utilities Company. The medal will be presented to Dr. Langmuir by Professor Julius Stieglitz, of the University of Chicago.

DR. JAMES G. NEEDHAM, professor of entomology at Cornell University, has been designated by the Peking Society of Natural History as the first recipient of the King Senior Memorial Gold Medal in recognition of his contributions to the knowledge of the fauna and flora of China.

VILLANOVA COLLEGE will present its 1930 Mendel Medal, awarded annually for distinguished service in the advancement of science, to Albert Francis Zahm, chief of the division of aeronautics in the Library of Congress, Washington, D. C.

MARVIN R. THOMPSON, assistant pharmacologist of the Food and Drug Administration, U. S. Department of Agriculture, is the winner of the Ebert medal awarded by the American Pharmaceutical Association. The prize goes to the author who at the annual meeting of the association presents the paper "contributing most to the science of pharmacy." Mr. Thompson, who is twenty-four years old, is the youngest man to receive this award. His subject was "The Pharmacology of Ergot."

THE Fritz Schaudinn Medal, in commemoration of the discoverer of *Spirochaeta pallida*, has been awarded for outstanding work in microbiology to Professors M. Hartmann, Berlin, F. d'Herelle, formerly of Paris, and now at Yale University, and to E. Reichenow, Hamburg. The award was made on March 3, the twenty-fifth anniversary of the discovery of the micro-organism causing syphilis, by an international committee of jurors appointed by the Tropical Institute in Hamburg.

AT a meeting of the Linnean Society of London on May 1 the president announced that the Linnean Gold Medal for 1930 had been awarded to Dr. James Peter Hill, F.R.S., professor of embryology, University College, London, and would be presented at the anniversary meeting on May 24. On the same date the Trail Award and Medal will be presented to Dr. Kathleen Bever Blackburn, of the botanical department of Armstrong College, Newcastle-on-Tyne.

AN honorary life fellowship of the Ross Institute was recently bestowed on Rai G. C. Chatterjee Bahadur, Bengal, India, for his work in malaria control.

DR. JOHN D. CLARK, professor of chemistry at the University of New Mexico, Albuquerque, has been elected president of the Southwestern Division of the American Association for the Advancement of Science.

DR. WALTER A. BASTEDO, of New York, was elected president of the United States Pharmacopoeia at the recent decennial convention in Washington. Dr. H. A. B. Dunning, of Baltimore, was elected vice-president. Among those elected to the revision committee are Dr. Reid Hunt, professor of pharmacology, and Dr. Henry Christian, professor of medicine, both of Harvard University, and Dr. C. W. Edmunds, of the University of Michigan.

DR. HENRY C. CHRISTENSEN, Chicago, secretary of the National Association of Boards of Pharmacy since 1914, was elected president of the American Pharmaceutical Association at the recent Baltimore meeting. Other officers are: E. F. Kelly, of Baltimore, *secretary;* Walter D. Adams, of Forney, Texas, *first vice-president;* D. B. R. Johnson, of Norma, Okla., *second vice-president;* C. W. Holden, of Essex Fells, N. J., *treasurer,* and Drs. H. V. Arny, New York; T. J. Bradley, Boston, and W. B. Day, Chicago, *members of the council.* The convention next year will be held in August at Miami, Florida.

J. B. FAIRBAIRN has been appointed deputy minister of agriculture for Ontario. W. B. Roadhouse, who has been deputy minister since 1912, has resigned in order to accept the chairmanship of the Ontario Agricultural Development Board.

LIEUTENANT-COLONEL FIELDING H. GARRISON who has been in the United States Medical Service since 1891 has taken up his work as head librarian of the

William H. Welch Medical Library, at the Johns Hopkins University.

Dr. Thomas G. Thompson, professor of chemistry at the University of Washington, was recently appointed to the directorship of the new University of Washington Oceanographical Laboratories. Dr. Thompson's appointment is effective on October 1.

Dr. F. L. Pickett, head of the department of botany at the State College of Washington, has been made dean of the graduate school.

Dr. Fred Griffee, biologist in plant breeding at the Maine Agricultural Experiment Station, Orono, has been made assistant director of the station. Dr. Griffee will assist Director Warner J. Morse, who has been granted a leave of absence because of illness.

Professor A. J. Olney has been appointed head of the department of horticulture at the University of Kentucky to succeed the late Professor C. W. Mathews. Professor Olney, who is a graduate of Michigan State College and the University of Chicago, will be in charge of the experimental work in fruit and vegetable growing at the three experiment stations and will head the teaching of horticulture in the College of Agriculture.

Dr. Paul H. Stevenson, associate professor of anatomy at Peking Union Medical College, will teach in the University of California summer session from June 30 to August 9, in the department of anthropology.

Dr. Willem Van Royen, of the Netherlands Chamber of Commerce, New York City, has been appointed instructor of geography in the University of Nebraska.

Dr. Max M. Ellis, professor of physiology in the school of medicine of the University of Missouri, has been appointed regional director of investigation in the Bureau of Fisheries with the title "In Charge, Fishery Investigations, Interior Waters." He will head a staff of biologists engaged with ecological, fishery and pollution studies in the rivers of the Mississippi River drainage, but will not sever completely his connection with the university. Attention will be directed to perfecting the method of large-scale propagation of fresh-water mussels that has been developed from Dr. Ellis's experiments as a temporary investigator for the bureau since 1926.

Dr. C. L. Huskins, research geneticist and cytologist at the John Innes Horticultural Institution, London, England, is returning to Canada about September 1, to take up his new duties as associate professor of botany at McGill University.

Dr. Alexander Wetmore, assistant secretary of the Smithsonian Institution; Dr. Casey Wood, honorary associate in ornithology of the U. S. National Museum, and Harry S. Swarth, inspector of foreign birds under the Geological Survey at San Francisco, have been designated by the Department of State to represent the United States at the seventh International Ornithological Congress, which will convene at Amsterdam from June 1 to 7. The sixth congress was held at Copenhagen in 1926, at which were present representatives from thirty-two countries.

Dr. George K. Burgess, director of the Bureau of Standards, delivered an address to the Sigma Xi Club of the University of Alabama on May 7.

Dr. Arthur D. Little, president of Arthur D. Little, Inc., addressed the spring meeting of the American Iron and Steel Institute at New York on May 9, on "The Contribution of Science to the Iron and Steel Industry."

Dr. Lafayette B. Mendel, Sterling professor of physiological chemistry in Yale University, gave two illustrated lectures at Cornell University on May 8 and 9, under the auspices of the Jacob H. Schiff Foundation. His subject was: "Some Relations of Diet to the Formation of Body Fat."

Professor F. K. Richtmyer, of Cornell University, addressed two open meetings of the Gamma chapter of Sigma Pi Sigma, honorary physics fraternity, at the Pennsylvania State College, on May 6 and 7. He also spoke to the combined physics and chemistry seminars on the "X-Ray Satellites." Dr. Richtmyer was initiated as an honorary member of the fraternity during his visit.

Dr. Karl F. Herzfeld, professor of physics in the Johns Hopkins University, will lecture at the Cooper Union in New York City on each Tuesday evening during the next college year. These lectures will constitute a survey of the field of modern physics and several evenings will be given to each of the following topics: Crystal structure, absorption and emission of light in the quantum theory, photochemistry, dielectric polarization and the structure of molecules, atomic structure, band spectra and the structure of gas molecules. The lectures have been arranged by the departments of chemical engineering and physics at the Cooper Union and will be open without payment of fees to those who have had the necessary mathematical preparation.

Professor Robert Chambers, of New York University, has been invited by the Physiological Institute in Moscow to give a series of lectures and demonstrations in June on the micromanipulative technique and the physical properties of the living cell. He left for Europe on May 9. In August he will give a lecture with motion pictures at the Cell Physiological Congress in Amsterdam, which meets from August 4 to 9.

PROFESSOR ROBERT H. GAULT, of Northwestern University, is giving a lecture this summer in the following foreign universities: Cambridge, Manchester, Edinburgh, Hamburg, Rostock, Halle (Nose and Ear Clinic) and Leipzig. His subject is "On the Effect of Dual (Tactual-Visual) Stimulation from Spoken Languages and an Analysis of the Effect."

THE first course of Scott Lectures was given by Dr. Niels Bohr at the University of Cambridge on May 12, 14 and 16, on "The Principles of Atomic Theory."

THE twenty-fifth anniversary of the founding of the Harvey Society, New York, was celebrated on May 15, when Dr. Rufus I. Cole gave an address on "The Progress of Medicine during the Past Twenty-five Years, as Exemplified by the Harvey Lectures." Following the lecture the "Harvey Film," prepared by Sir Thomas Lewis and Dr. H. H. Dale, was exhibited. After the meeting there was a supper at the Hotel Plaza. Dr. G. Canby Robinson presided and there were speeches by Dr. John A. Hartwell, Dr. Graham Lusk, Dr. Harvey Cushing and Dr. William H. Welch.

NINE additional chapters of Sigma Pi Sigma, national honorary physics fraternity, are being installed this spring, bringing the roll up to nineteen chapters by the end of the college year. Dr. Marsh W. White, associate professor of physics at the Pennsylvania State College and the national secretary of the society, is conducting the installations. Chapters are being established at the University of Kentucky on May 15, the University of Oklahoma on May 17, Park College on May 19, William Jewell College on May 20, Morningside College on May 21, the University of Colorado on May 22, the University of Washington on May 26, Lake Forest College on May 31 and the College of Wooster on June 2.

THE spring meeting of the Tennessee Academy of Science for 1930 was held in Chattanooga, on April 11 and 12. The meeting was well attended by members from Middle and East Tennessee, representatives of eight educational institutions from these sections of the state having papers on the program. Tennessee caves were discussed Friday afternoon in a "Cave Symposium," and on Saturday afternoon Lookout Mountain Caverns and points of scenic and historic interest in the vicinity of Chattanooga were visited. Two public lectures were given Saturday evening: "Short Wave Length Radio Demonstration," by Francis G. Slack, of Vanderbilt University, and "Principles of Radio Broadcasting and Reception," by C. R. Fountain, of George Peabody College for Teachers. The University of Chattanooga as host for the meeting provided halls and ample facilities for the sessions and generous entertainment during intervals. The academy was privileged to have as a guest Dr. W. J. Humphreys, of the U. S. Weather Bureau, who brought greetings from the American Association for the Advancement of Science and delivered on Friday evening an illustrated public lecture on "Beauties of the Sky—Halo, Rainbow, Lightning and Every Kind of Cloud that Floats." Dr. Francis G. Slack, associate professor of physics, Vanderbilt University, was elected vice-president, in place of Dr. David W. Cornelius, who became president on the death of Dr. F. B. Dresslar, on January 19.

THE Kentucky Academy of Science held its seventeenth annual meeting at Centre College, Danville, on May 3. The president, Dr. Frank L. Rainey, delivered an address on the teaching of science in colleges of liberal arts. Papers were read on many subjects. Dr. A. M. Reese, of West Virginia University, who represented the American Association for the Advancement of Science, gave an illustrated lecture on "The Habits of the American Alligator." The officers elected were: V. F. Payne, Transylvania College, *president;* Mrs. Clara Chassell Cooper, Richmond State Normal School, *vice-president;* A. M. Peter, University of Kentucky, *secretary;* W. S. Anderson, University of Kentucky, *treasurer;* Austin R. Middleton, University of Louisville, representative in the council of the American Association for the Advancement of Science; W. R. Jillson, state geologist, Frankfort, member of the committee on publications. Centre College entertained the academy at luncheon.

THE fifteenth annual meeting of the South Dakota Academy of Science was held at Vermillion, South Dakota, on May 1 and 2. The first session was devoted to papers by the members followed by the president's address—"Incursions of the Cretaceous Sea." On the evening of May 1 a complimentary smoker was given by the local committee at the club house of the Vermillion Golf Association. After the usual academy dinner on May 2 Dr. Raymond J. Pool, of the botany department of the University of Nebraska, spoke on "Wild Life on the High Peaks of the Rockies." The following officers were elected for 1930–31: V. A. Lowry, Eastern State Teachers College, *president;* B. B. Brackett, University of South Dakota, *first vice-president;* J. H. Jensen, Northern State Teachers College of South Dakota, *second vice-president,* and A. L. Haines, University of South Dakota, *secretary-treasurer.*

A FIRE that destroyed one of the main buildings of Georgetown College, Georgetown, Kentucky, recently, swept the biological laboratories that were located on the second and third floors. Equipment to the value of ten thousand dollars was lost. Enough microscopes were saved to enable the department to begin work immediately in the college gymnasium and no laboratory periods were missed. The department will be housed temporarily in a new building that is being erected on the campus until plans for rebuilding can be completed. The departmental library suffered the loss of files of SCIENCE dating back nearly twenty-five years, many books, herbaria, collections of material and files of several scientific publications. In sending this information Professor Robt. T. Hinton writes: "Any gifts of duplicate copies of SCIENCE, *The Scientific Monthly* and various biological publications would be greatly appreciated if institutions or individuals have them to spare."

THE new building of the School of Pharmacy of the University of Maryland was dedicated on May 10 during the meeting in Baltimore of the American Pharmaceutical Association. The ceremony was held at Old Westminster Church and most of the attending pharmacists visited the tomb of Edgar Allan Poe in the historical churchyard. Dr. Edward Kremers, director of pharmacy at the University of Wisconsin, delivered an address. State and city officials also spoke.

PROFESSOR GEORGE GRANT MACCURDY, of Yale University, director of the American School of Prehistoric Research, has received word from Dr. Hackett, who with Mr. Theodore D. McCown is representing the school in the latter's joint excavations with the British School of Archeology at Jerusalem, that during the first ten days of April no less than 5,000 tools dating from the Aurignacian Epoch of the Old Stone Age were dug from a single cave of the group south of Haifa. Miss D. A. E. Garrod, of the British school, is in charge. The season's excavations will terminate in time for Dr. Hackett and Mr. McCown to take part in the work of the tenth annual summer term of the American School of Prehistoric Research, which will open in Paris on July 1, under the direction of Professor MacCurdy. Assisting him in the field there will be three of his former students: J. T. Russell, Jr., U. S. National Museum; V. J. Fewkes, University of Pennsylvania, and Robert Ehrich, Harvard University.

AN American Committee for International Wild Life Protection has been formed for the purpose of cooperating in every way with existing foreign governments and institutions working for wild life conservation. This committee is made up of representatives of prominent American institutions and organizations interested in these matters, and particularly cooperating in this work with the British Society for the Preservation of the Fauna of the Empire and the Office for International Nature Protection at Brussels. The following institutions have already been elected to the American Committee: Museum of Comparative Zoology—Dr. Thomas Barbour; Field Museum of Natural History—Mr. Stanley Field; Camp Fire Club—Mr. William B. Greeley; California—Major F. R. Burnham. Executive Committee: Dr. John C. Phillips, *chairman*, for the Boone and Crockett Club; Mr. George D. Pratt, for the American Museum of Natural History; Mr. Kermit Roosevelt, for the New York Zoological Society, and Mr. Harold J. Coolidge, Jr., *secretary*, Museum of Comparative Zoology, Cambridge, Massachusetts.

DISCUSSION

THE TAU EFFECT—AN EXAMPLE OF PSYCHOLOGICAL RELATIVITY

IF three spots on the back of the hand or arm are touched lightly with the point of a pencil in quick succession, two spatial intervals will be defined by the three stimulations. If one is asked to judge whether the second spatial interval is equal to, greater than or less than the first interval, it will be found that the observer's report depends more upon the time interval between stimulations than upon the actual distances between places touched. The same has been found to hold true in vision, hearing and the estimation of the extent to which the hand or arm has been moved through space. Thus, if we stimulate three spots on the skin so that the first distance is 20 mm and the second 10 mm, but the time interval between the second and third stimulations is twice as great as that between the first and second, then the distance between the second and third spots will be judged as nearly twice as great as the first. The conditions may be reversed to give the opposite effect; *i.e.*, by making the second distance twice as long as the first, but the time interval much shorter, the judgment will be that the second distance is very much smaller than the first. While this phenomenon has been reported before in the psychological literature, it has not been labeled in such a way as to give it the independent status it deserves. I therefore propose that it be called the *Tau* effect because it obeys definite laws, can be measured and is not due to "imagination," "attention," "suggestion" or any other peculiarly mentalistic mechanism. It illustrates beautifully the dependence of space on time in our estimations of visual, tactile, kinesthetic and auditory space. In order to produce the *Tau* effect we may say, in general, vary the time interval in the opposite direction to the space interval and the latter will be distorted accordingly. So easy is it to demonstrate the *Tau* effect that it can be used as a parlor trick or game.

It may be thought that we are here dealing with a lightly dispelled illusion or error in judgment in which the subject unwittingly is judging the time intervals instead of the spatial distance between the spots touched. Nothing could be farther from the truth, for even when the subject knows what the effect consists in and is due to, if we vary our conditions by reversing the spatio-temporal relations, the subject will be wholly lost as to whether or not the spatial intervals are really equal or different and in what sense they differ. We have here, I believe, a *bona fide* example of the interdependence of time and space. They are so intimately related psychologically, as well as physically, that by varying them in opposite sense it is possible to demonstrate directly to an observer the distortions in space which relativists have told us about. It is interesting to note that whereas it is doubtful if the physicist can ever hope to do more than make relativity an intelligible abstraction to the layman, the psychologist by this simple experiment can directly demonstrate what the interdependence of time and space means in direct experience.

Several factors influencing the *Tau* effect which should be noted if one is to get it at its best are the following: (1) care should be taken to touch all the spots equally so that no one stands out more than another; (2) the greater (or less) the spatial distance between the second and third stimuli as compared with the first and second, the less (or greater) must the time interval be between the latter as compared with the former, if the effect is to appear; (3) the optimal effect is limited by the actual spatio-temporal intervals used: we have found that distances as great as 80 mm on the back of the arm and times as long as 1 second may be used. There is practically no lower time limit, although the second temporal interval should not bear a greater ratio to the first than 3 or 4 to 1.

A fuller, quantitative account will appear in one of the psychological journals.

Harry Helson

Bryn Mawr College

ON THE AGE OF THE NEW ALBANY SHALE

In an interesting article on "Petrified Wood in the New Albany Shale," published in Science for December 13, 1929, Chester A. Arnold described an occurrence of fossil wood in the upper part of the New Albany shale in Scott County, Indiana, which he referred to the genus Callixylon. The concluding paragraph of his contribution is as follows:

> Although the wood is widely scattered, it appears to occur mostly near the top of the New Albany formation. While formerly considered as belonging to the upper Devonian and of the same age as the Genesee shale of New York, the New Albany shale is now viewed by some competent authorities as being, at least in part, of lower Mississippian age. This would place the Indiana wood in the Mississippian, and thus extend the range of Callixylon from the Devonian up into the Carboniferous. However, there is no record of its occurrence any higher than this basal member.

It seems to the present writer that Mr. Arnold is not justified in his conclusion quoted above. The New Albany shale as it occurs in the type locality in the vicinity of New Albany, Indiana, is a definite formation. Other black shales present in eastern Ohio, Kentucky and Tennessee, east of the Cincinnati anticline, were until a few years ago thought to be the equivalent of the New Albany shale at New Albany, Indiana. In recent years a part of the black shale in eastern Ohio, Kentucky and Tennessee has been shown to be of early Mississippian age. However, this does not prove that any part of the New Albany shale at New Albany, Indiana, is younger than the Upper Devonian, but rather that such part of the black shale of eastern Ohio and Kentucky as is now known to be of early Mississippian age is younger than any part of the typical New Albany shale at New Albany, Indiana. So far as known to the present writer, no one has ever shown that any part of the New Albany shale, as it is developed in the type locality near New Albany or farther north in Indiana or south in Kentucky, west of the Cincinnati anticline, is younger than upper Devonian age. Therefore, it seems that the more logical conclusion to be drawn from the occurrence of Callixylon in the upper part of the New Albany shale in Scott County, Indiana, would be that this shale is of upper Devonian age, because the genus of fossil wood that occurs in it has never been found in strata younger than the Devonian.

T. E. Savage

University of Illinois

FIREFLIES FLASHING IN UNISON

Several times in recent years correspondents of Science have directed attention to the synchronous flashing of a swarm of fireflies or other insects, as at page 132 in the issue for January 31, 1930.

A theory to explain this behavior of the insects is as follows. Doubtless each individual insect has a normal tendency to flash at approximately equal intervals, these intervals being nearly the same for many different individuals of the swarm. Suppose that in each insect there is an equipment that functions thus: when the normal time to flash is nearly attained, incident light on the insect hastens the occurrence of the event. In other words, if one of the insects is almost ready to flash and sees other insects flash, then it flashes sooner than otherwise. On the foregoing hypothesis, it follows that there may be a tendency for the insects to fall in step and flash synchronously.

Everybody knows the flashing electric glow lamps for advertising and for warning signals. Some of these of longer period (five or ten seconds) have apparatus in which a condition (like the heat expansion of a core by an electric heating coil) builds up with time until it causes a flash which wipes out that condition, which then begins and builds up anew, and so on. Let us have a number of such lamps on a bench with their periods nearly, but not exactly, the same. Suppose that with each lamp there is a respective photoelectric cell connected to intensify the said condition (as by increasing the electric current in the heating coil) when light falls on the cell. First, screen the lamps from each other; there will be no sustained synchronism. Next, remove the screen; with suitable adjustment of the apparatus, the lamps will fall in step and flash in synchronism.

Consider two flashing lamps (or insects) A and B of periods slightly different, A having the shorter period. Eventually there will come a time when B's normal flash will be promptly after A's flash. Thereafter, were it not for the photoelectric cell (or in the case of the insect, the special equipment assumed by the present theory), B would flash later and later compared with A. But because of the cell (or equipment), B is accelerated each time enough to keep it in step with A. Further development of the principle here involved could be reached by extending the discussion to cases of three or more units.

An individual flashing firefly should be confined and its approximate period ascertained by observation, then a light should be flashed in its presence at a period slightly less; would the firefly fall into step? Various intensities and kinds of light should be tried.

Carl A. Richmond

Tyngsboro, Massachusetts

PRESSURE IN A FLUID

W. H. Pielemeier proposes in the issue of Science for April 25 that the concept of pressure potential be introduced, in the treatment of hydrodynamics. It seems to me that he has misconceived the nature of pressure. He states that according to the defining equation, $p = F \div A$, pressure is a vector quantity. This is not the case. In the equation F is a vector normal to the surface, and A is a vector in the same direction. The quotient is a scalar quantity. p is therefore a scalar. Inasmuch as we have already the potential function represented by the product of pressure and the specific volume of the fluid, it seems unnecessary to introduce another potential function so closely related to the one already in use.

H. H. Marvin

University of Nebraska

LAWS OF ORBITAL MOTION

Recent correspondence has directed my attention to a law of planetary distances given in Science for April 5, 1929, by Professor Caswell, who states that so far as he is aware the relation has not hitherto been reported.

As a matter of fact, the law was enunciated by me ten years ago, in *The Observatory*, No. 545, November, 1919, and was shown to apply not only to the Sun and planets but also to systems of satellites.

A. F. Dufton

Greenbank, Garston,
Hertfordshire, England

SPECIAL CORRESPONDENCE

BARRO COLORADO ISLAND BIOLOGICAL STATION

Dr. Thomas Barbour, chairman of the executive committee of the Barro Colorado Island Biological Station in the Panama Canal Zone, has submitted to the division of biology and agriculture of the National Research Council the sixth annual report of the station, covering the period from March 1, 1928, to February 28, 1929.

Dr. Barbour reports that the following institutions have continued their annual $300 table subscriptions: American Museum of Natural History, Harvard University, Missouri Botanical Garden, Smithsonian Institution, Johns Hopkins University and the University of Michigan. He is also glad to be able to announce that the Carnegie Institution and the Field Museum of Natural History have joined the institutions that help support the station through table subscriptions. There should be more.

The total expenses for the year were $6,052.80, and the total income received was $6,489.45. This total was made up by table subscriptions, personal donations (among which Dr. Barbour's account for two thirds of the sum) and subsistence fees from scientific workers.

The station is given the advantage of various concessions made by the government officials of the Panama Canal Zone and several steamship and railway companies, which greatly lessen the traveling and other personal expenses of investigators. Particulars concerning transportation from the United States to the Canal Zone and expenses while at the station can be had by application to Dr. Thomas Barbour, Museum of Comparative Zoology, Cambridge, Massachusetts. Those planning to work at the station should state approximately when they expect to sail and from which port. In some cases return transportation can be arranged with the steamship company before leaving the United States. Passports are not required in the Canal Zone.

The governor of the Panama Canal issues to visiting scientists a complimentary annual card pass on the Panama Railroad and also a card authorizing purchases in the Panama Canal commissaries. The governor has also generously extended to the working scientists of the station and to their families the same rates at the Gorgas Hospital that apply to families of employes of the Panama Canal. These rates are extremely reasonable and the hospital facilities are excellent in every way. Dr. Barbour's report especially acknowledges the continued cooperation of government officials in every department. Without this constant willingness on the part of these officials to support the station, its maintenance would be far more difficult.

Much has been done during the year in the way of extending trails and of making repairs and additions to the building and material equipment of the station. The old dock has been replaced by a new one. The guest house has been given more ventilation and light. All the buildings have been repainted. Several interesting long-time experiments on termite resistance of various kinds of wood are under way.

Dr. Barbour has prepared a list of papers published since the opening of the station, presenting the results of work done at the station by visiting investigators. This list includes 118 titles. Conspicuous among these publications is the recent book of Dr. Frank M. Chapman entitled "My Tropical Air Castle." This is a charming and authentically informing book of Barro Colorado Island natural history.

During the past year sixteen investigators have worked at the station for varying lengths of time, and about one hundred other persons visited the island.

More financial help is needed by the station for material equipment of one kind and another, and for work to be done on trails and in connection with the buildings of the station. A few thousand dollars more available each year to the station would enable great improvements to be made in it, and afford greatly improved opportunities for the investigators. The cooperation of universities and biological organizations by table subscriptions is the simplest and most desirable way to effect the needed aid. In the meantime, thanks to the generosity of Dr. Barbour and others, the station offers a unique opportunity to those who would work in the American tropics.

VERNON KELLOGG,
Permanent Secretary
NATIONAL RESEARCH COUNCIL

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN ELECTRICAL RECORDING MANOMETER

IT is frequently desirable when studying pressure changes in the circulatory and respiratory systems to be able to photograph simultaneously these pressure changes together with other variables on the same strip of film. Previous set-ups for this purpose demand a rather cumbersome optical system which is particularly disadvantageous because it interferes with the recording of other phenomena on the same film. The recording manometer here described possesses the advantages that it can be easily and cheaply constructed from available laboratory materials, is simple and can be used in conjunction with a multi-unit oscillograph, the other elements of which can be utilized for time lines and other desired records.

The constants as given are of course applicable only when used with oscillograph units similar to those employed here, but slight modifications in resistances would adapt it to any oscillograph or fairly high speed galvanometer.

The parts required consist of:

a. an ordinary blood-pressure mercury manometer
b. 900 ohm variable resistor
c. 1½ to 6 volts in dry cells
d. oscillograph or galvanometer
f. connection to resistance wire
g. glass tubing support for resistance wire
h, h, m. resistance wire No. 30 nichrome

The resistance wire is fastened to a length of drawn out glass tubing by means of small sealing-wax bridges. The tubing should be as small as possible and still be firm enough to keep the resistance wire fairly taut. A free airway must be provided through the cork in the manometer by means of v-shaped grooves cut into the cork. The setting of the variable resistor will be dependent upon the resistance of the oscillograph unit, the voltage employed and the sensitivity desired. With a Westinghouse supersensitive oscillograph unit, the deflection at 22 inches optical distance corresponded roughly to the fluctuations of the mercury when the resistance was set at 100 ohms and the battery potential was 1½ volts. All the internal parts of the manometer should be kept scrupulously clean to avoid uneven flow of the mercury and consequent errors in the records.

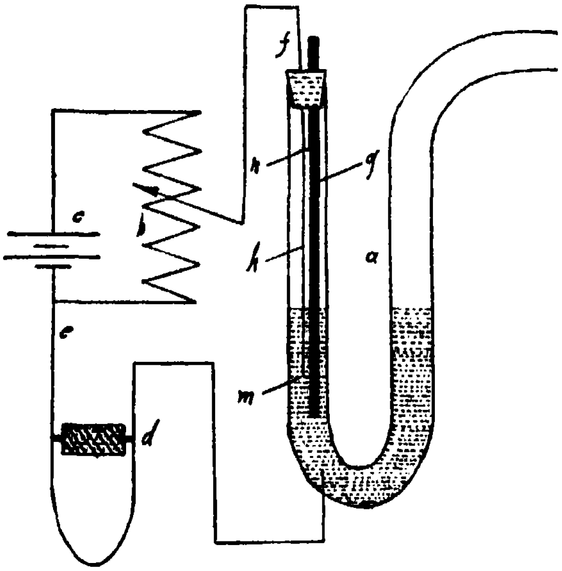

FIG. 1

The same arrangement also should be of value as a myograph for recording muscular contractions by connecting the muscle to a tambour and the tambour to the manometer.

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PLANT JUICE CLARIFICATION FOR NITRATE NITROGEN DETERMINATIONS

THE introduction of the small laboratory hydraulic press has stimulated scientific investigation concerning the chemical composition of plant juices. Phosphorus and potassium may be determined to a fair degree of accuracy, but the determination of nitrogen existing in the juice as nitrate presents difficulties that are almost insurmountable because of the organic matter present. In plant juices the nitrates are usually determined by the colorimetric phenoldisulphonic acid method on account of its rapidity and ease of manipulation. In order to obtain reliable results a clear solution of the juice is absolutely essential. Many clarifying agents have been used, such as copper sulphate, iron hydroxide, aluminum hydroxide, calcium carbonate and a host of other substances. These reagents have not always been satisfactory because of brown tints which are developed when the evaporated portion is compared with a standard nitrate solution. Using the expressed juice from the corn plant the following method has given clear extracts and clear tints when matched with a standard in a colorimeter. The method as developed in this laboratory is as follows.

Measure out 10 cc of the corn juice into a small evaporating dish. Add sufficient silver sulphate to precipitate any chlorides that may be present. Evaporate the solution containing the silver sulphate to dryness on a water bath. Cool and rub up the residue using cold water. Transfer to a 200-cc graduated flask, make up to mark and filter off 100 cc of the solution. Transfer the solution to a Nessler tube 3 cm in diameter and 20 cm in length fitted with a 2-hole rubber stopper carrying a tube reaching to the bottom of the liquid and a shorter one just passing through the stopper. Add 2 grams of G. Elf carbon black and mix thoroughly. Attach the shorter tube to a suction pump and aspirate for four hours at the rate of 30 bubbles per minute. Filter through two dry 11 cm S. and S. filter-papers and take 10 cc of the clear filtrate for the determination of nitrogen as nitrate. Evaporate to dryness and add 2 cc of the phenoldisulphonic acid reagent and allow to stand for 10 minutes on a beaker filled with cold water. This keeps the dish cold while the reaction is taking place. Add 20 cc water and allow the residue to dissolve slowly. Cool thoroughly and develop the yellow color with 1 to 1 ammonium hydroxide solution and make to a volume of 100 cc. Compare with a standard nitrate solution in a Duboscq or other standard colorimeter using a standard potassium nitrate solution containing 0.1 milligram of nitrogen to each 100 cc of water.

By evaporating and drying the juice at the temperature of boiling water and taking up with cold water a solution is obtained which is easily clarified by carbon black, and the clarification appears to be intensified by passing a slow current of air through the solution which keeps the carbon black continually moving. This method of clarification has been tried on corn juice with success, and further studies as to its perfection and application to other plant juices are now under way.

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SPECIAL ARTICLES

THE ISOLATION OF NITROSOMONAS AND NITROBACTER BY THE SINGLE CELL TECHNIQUE[1]

SINCE the classical work of Winogradsky in the late eighties, numerous attempts have been made to isolate the nitrifying organisms, but with few exceptions these have failed, and his work in its entirety has never been repeated. He used a modification of the plate method of Koch, and after overcoming many difficulties reported the isolation of both groups. The failures in isolation of these organisms have been due largely to the use of the plate method, a method which is not satisfactory for slowly growing organisms which do not readily form colonies.

These specialized organisms are usually cultivated in highly selective media and the cultures are called enrichments. For example, the only energy source in the medium for the study of the *Nitrosomonas* group is an ammonium salt and for the *Nitrobacter* group, sodium nitrite. Theoretically the bacteria which are unable to utilize these sources of energy should die out and those which are able to utilize the energy should increase in numbers. In a general way this is what happens, but it is not the whole story. If it were it would be an easy matter to make a few transfers followed by dilutions and in this way secure a pure culture of the desired form. In practice, however, all the dilution experiments have failed to yield pure cultures. As noted above, Winogradsky reported successful results by the use of the plate method and a few others have also reported isolations, but the vast majority have failed. This is due to the fact that most of the colonies which form on the plates contain other organisms which do not oxidize the ammonium salt or the nitrite. Furthermore, these colonies are microscopic and hard to study or to use for isolations. The criterion of purity (the failure to grow when inoculated into nutrient broth) is not satisfactory.

In the spring of 1928 the author began some studies on nitrifying organisms using the plate method. The results were not satisfactory. When the work was resumed in the following November, it was thought worth while to try the isolation of the organisms by picking single cells from the enrichment cultures. The first trials were very discouraging; it was slow and tedious to isolate organisms from the cultures having insoluble carbonates present which is the case in *Nitrosomonas* cultures. Of the first 365 cells isolated only thirty-four grew and none of them was found to oxidize the ammonium salt. This work shows, however, that non-oxidizing forms not only persist in the enrichments but that it is possible for them to develop from single cells in a mineral solution. It was clear that the enrichments must be improved, *i.e.*, the proportion of nitrifiers to other forms increased, if the method was to be successful. If some chemical could be found which is not toxic to the nitrifiers and which at the same time would materially retard the growth of other soil forms in the cultures, a satisfactory enrichment for isolations would be secured. Some of the dyes were tried for this purpose on the *Nitrosomonas* group but they were found to be more toxic to the nitrifier than to the contaminating forms in the cultures. Other chemicals were tried but without success. Finally copper carbonate when used with an equal amount of calcium carbonate was found to reduce the numbers of organisms which develop on a nutrient agar plate (nitrifiers do not develop on this medium) while it did not stop the oxidation. From enrichments prepared with this compound only some twenty cells were picked before a culture was secured which would oxidize the ammonium salt as rapidly as the enrichment from which it was isolated.

Fifty-six cells were isolated from the first pure culture, and of these two developed and oxidized the ammonium salt as rapidly as the mother culture.

In the case of the *Nitrobacter* group (those which oxidize the nitrites to nitrates) it was found recently by Prouty[2] that they could tolerate certain dyes. This treatment ought to reduce the numbers of contaminating forms in the cultures but there are as yet insufficient data on the subject. Enrichments were prepared in the usual way, that is, by transferring to fresh sterile medium when all the nitrites had disappeared from the cultures. After the fourth transfer since starting with soil, the cultures were exposed to a 1 per cent. solution of rosanaline hydrochloride for ten minutes, inoculated into fresh sterile medium and set aside for ten to fifteen days. From such a culture 101 cells were picked, of which fifteen grew and thirteen oxidized the nitrites as rapidly as the enrichment from which they had been isolated. Here it should be noted that two cells developed in the mineral solution which would not oxidize the nitrite. This is further evidence that non-oxidizing forms readily develop in the cultures. An average of twenty-two cells were isolated per day, but this does not include the time required for making media and preparing the apparatus for isolations.

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[1] This work was made possible by the National Research Council and carried out in the laboratories of agricultural bacteriology, University of Wisconsin. The author is indebted to Dr. E. B. Fred for helpful suggestions and criticisms during the course of the work.

[2] Chas. C. Prouty, "The Use of Dyes in the Isolation of a Nitrite-oxidizing Organism," *Soil Sci.*, 28: 125–136, 1929.

Reisolations by picking cells from one of the pure cultures were made. Twenty cells were isolated and ten of them grew and oxidized the nitrites. If the percentage of cells which grow is the same in the isolations from crude cultures as from pure cultures it would indicate that only 30 per cent. of the cells in the enrichments were nitrite-oxidizers. The results are very satisfactory since it required only a few days to secure these cultures.

From this brief discussion it is seen that it is possible to secure pure cultures directly from enrichments by isolating single organisms; and when all the factors are considered, this method is more satisfactory for the nitrifiers than the plate method which does not usually yield pure cultures and which requires a great deal of time for carrying out.

Details of the method used and descriptions of the organisms isolated will soon be published.

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THE BORON CONTENT OF ORANGES

In connection with a study of the relation between the boron content of irrigation water and a certain type of injury to citrus and walnut trees in southern California, it has been observed that these plants take up substantial quantities of boron which is deposited in the leaves. This fact has made it possible to diagnose cases of boron injury. Boron occurs as a natural constituent of practically all irrigation waters in southern California. In most of these waters the content of elemental boron ranges from .15 to .3 parts per million, while in those supplies that have caused trouble the boron content may range up to 2.5 parts per million. Orange trees irrigated with low-boron water have in their mature leaves from 50 to 150 parts per million of boron, based on the dry weight of the leaves. Those irrigated with high-boron water may show from 600 to 1,000 parts per million of boron to the dry weight of the leaves.

A very few analyses of fruits and of twigs or chlorophyll-bearing branches, chiefly of lemons, have indicated that most of the boron taken up by these trees is deposited in the leaves, but it has seemed worth while to ascertain whether or not there are appreciable differences in the boron content of the fruits produced by trees having pronounced differences in the boron content of their leaves. For this purpose a number of analyses have been made of fruits of navel orange trees grown under different conditions with respect to the boron content of the irrigation water and known to have very different proportions of boron in the leaves. In view of the fact that the skin of the orange is green when the fruit is young, it seemed desirable to make separate analyses of the skin and the pulp.

The fruits to be analyzed were picked from the trees in the early part of March, 1929, when they were fully mature. At the same time samples of mature leaves were picked from the same trees. The boron content of the irrigation water used in each grove had been determined previously by analyzing a series of samples taken at different times. In preparing the fruits for analysis the skins were removed and the pulp was dried in the presence of sodium and calcium hydroxides to prevent the loss of any boron by volatilization. The peel was dried without treatment. When the fruit material was thoroughly dry it was ground to a fine meal and the boron content was determined by the Chapin method, as modified and developed by Wilcox in the Limoneira Laboratory. The leaves were analyzed by the same method.

The essential results of these analyses are given in the accompanying table. Samples 1 and 2 were obtained from the vicinity of Riverside, California, where the boron content of the irrigation water is low. Samples 3 and 4 were obtained in the Santa Clara Valley where some of the irrigation waters have a high boron content. The boron content of the

The Boron Content of Irrigation Water and of the Leaves and Fruit of Navel Oranges Irrigated with the Water

	No. 1	No. 2	No. 3	No. 4
Irrigation water, boron, parts per million	.20	.35	1.25	2.45
Leaves, boron, parts per million	35	90	515	854
Ave. fresh wt. per fruit, grams:				
Pulp	133.2	95.6	119.3	141.7
Peel	61.9	44.0	69.6	61.3
Ave. dry wt. per fruit, grams:				
Pulp	17.0	13.6	13.6	15.3
Peel	14.8	12.0	15.0	12.5
Boron content, parts per million:				
Dry pulp	10	11	22	38
Dry peel	21	22	40	44
Boron content per fruit, mgs:				
Pulp	0.17	0.15	0.30	0.58
Peel	0.31	0.26	0.60	0.55
Whole fruit	0.48	0.41	0.90	1.13
As boric acid, per fruit, mgs:				
Pulp	0.97	0.86	1.71	3.31
Peel	1.77	1.48	3.43	3.14
Whole fruit	2.74	2.34	5.14	6.45

irrigation water is given in the table in parts per million, while for the leaves and fruits the boron is reported in parts per million of the dry weight of the material, and also it is expressed in terms of milligrams of boron in each fruit and as the equivalent of boric acid (H_3BO_3) in the individual fruit and in the peel and pulp of the individual fruit.

These results show that there is a direct relation between the boron content of the irrigation water and that of the leaves, and that the same relationship holds with respect to the fruit, both for the peel and pulp.

The proportion of boron to dry weight is much lower in the fruit than in the leaves and the differences are much less. But it seems clear that not all the boron taken up by the orange tree from the soil solution is deposited in the leaves.

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THE NATIONAL ACADEMY OF SCIENCES. II

The band spectrum of ozone in the visible and photographic infra-red: OLIVER R. WULF (introduced by C. G. Abbot). Photographs of the spectrum of ozone have been taken over the range 10,000 A to 4,000 A, using a 33-meter absorption path and ozone-oxygen mixtures of low ozone concentration at one atmosphere pressure. The visible bands exhibit regularities but are diffuse and show no tendency to form heads. In the infra-red a new series of weak bands has been found.

Significance of recent cosmic ray experiments: R. A. MILLIKAN and I. S. BOWEN. The experiments reviewed are (1) those of Millikan on the influence of nuclear mass on the absorption coefficients of cosmic rays; (2) those of Millikan, Bowen and Chao on the absorption coefficient of monochromatic Th C″ rays; (3) those of Regener and of Millikan and Cameron on the absorption coefficient of cosmic rays at great depths in water; (4) those of Millikan and Cameron on the absorption coefficients of cosmic rays at great altitudes, and (5) those of Bothe and Kolhörster on the absorption coefficients of the beta rays accompanying cosmic rays. There have been but three possible ways suggested for accounting for the foregoing results. The enormous energies demanded by them are obtained (1) from cosmic electrical fields, (2) from the annihilation of matter, (3) from the building up of the heavy elements out of the light. The requirements of each of these theories are discussed and experiments suggested to decide between them.

Prediction of trans-Neptunian planets from the perturbations of Uranus: E. W. BROWN. The prediction of the place of a trans-Neptunian planet by Percival Lowell is shown to be due mainly to a mathematical relation which depends on the number of years during which the planet Uranus has been observed. This fact is brought out by a new analysis of the work of Lowell published in 1915. It is shown that this relation has the effect of giving a prediction of the place of an unknown planet whether the planet has any real existence or not. If the same methods had been used with the additional observations of Uranus which have been made since Lowell completed his work, the predicted place in the sky would have been changed by some twenty-five or thirty degrees. In calculating the disturbance of the motion of one planet by another, the astronomer has to use a measuring rod, the shape, size and position of which can be changed to fit the observations. The reason for this is that he does not know the exact shape, size or position of the orbit of the disturbed planet until he has obtained them from the observations. If the planet has been observed for a long time, the discovery of a new body which alters its motion will affect the measuring rod very little. But if the period of observation covers less than two revolutions of the planet round the sun, it may alter it considerably. Uranus had been continuously observed up to the time Lowell completed his work for about 130 years. In this interval it made only one and a half revolutions round the sun. Consequently, the measuring rod could be so adjusted that the apparent effect of an exterior planet during that time is very small, although the planet may be quite large. A small planet will produce little effect in any case. Thus small deviations of Uranus during that time may mean the existence of an exterior planet or no such planet at all. If we assume that a large planet exists it is shown, without any further use of the observations, that it will be predicted as nearest to or furthest away from Uranus in the middle of the interval, that is, about 1848. The same assumption gives a prediction that the planet will be nearest to or farthest away from the sun near the same date. These are almost exactly the dates found by Lowell and they give the chief factors in the predicted place. The result would be the same, however small the mass. Hence, it gives no indication as to whether the planet exists. The rest of Lowell's prediction depends on a few unreliable observations which were found in astronomical records made before it was known that Uranus was a planet and not a star. We already know that the planet is too small to satisfy these early observations, whether they are good or bad. It follows that the discovery of a new planet near the predicted position must be regarded as accidental, or perhaps as the first of others to be found beyond the orbit of Neptune. Although it seems impossible to give Lowell the credit of having predicted a new planet, his work undoubtedly stimulated a search for one. The value of a scientific hypothesis is not to be judged by its truth but by the impulse which it gives to the search for truth.

Note on the preceding paper: D. BROUWER (introduced by Ernest W. Brown).

Relative value of physiographic and paleontologic criteria in Pleistocene correlations: FRANK LEVERETT. The physiographic criteria embrace certain persistent and practically uniform conditions, such as rainfall, stream gradient and character of formation, which produce a given result in the modification of a land surface in a given time. Thus each glacial formation of the several which are present in glaciated districts shows a degree of erosion and weathering consistent with its age. So also do the Pleistocene marine terraces of the Atlantic and Gulf coastal plains. It is evident to a person who has studied both the glacial and the marine terraces that the Pensacola marine terrace which has a shore line in Florida at about 33 to 35 feet is no older than the late Wisconsin drift, but the higher marine terraces, Tsala Apopka and Newberry, are evidently of greater age than the Wisconsin drift. Turning now to the paleontologic criteria, it appears that the remains of many species of extinct vertebrates are found on the Pensacola terrace, some of them in close association with remains of man. From studies elsewhere it had been inferred that certain species had become extinct as early as Middle Pleistocene time. On this basis the terrace would be given a much greater age than is consistent with its freshness of contour, and the human remains if contemporary with those of the extinct animals would be given very great antiquity. This naturally raises the question of the value of paleontologic criteria in comparison with physiographic criteria. It is evident that the extinction of a species of either animal or plant life is due to factors of uncertain and varying character, which can not be predicted and which do not of necessity have time limitations. A given species may suffer extinction in one district long before it does in some other district in which conditions are more favorable for its continuation. The physiographic criteria may thus be made a basis for correlations where paleontologic evidence is of conflicting character. The physiographic criteria can be depended upon, however, only as a measure of age of relatively young formations. In older formations than the Pleistocene the paleontologic criteria are likely to be preferable to the physiographic. Neither set of criteria has the definiteness in determination of the age of an old formation that is possible in the determination of the age of a Pleistocene formation.

Some new fossils from the Middle Cambrian Burgess shale of British Columbia: RUDOLF RUEDEMANN. The Middle Cambrian Burgess shale of British Columbia afforded, some twenty years ago, to Dr. C. D. Walcott the richest and most varied Cambrian fossil association yet discovered. It consists of seaweeds, sponges, cystids, holothurians, medusae, annelids, crustaceans and merostomes. The material is preserved in a fine-grained shale to the finest details, as the intestinal canal and the hepatic caeca of the crustaceans, and its continued study is expected to throw a flood of light on the phylogeny of various classes of invertebrates. A hitherto unstudied portion of this collection, considered as probably consisting of graptolites, was turned over to the writer and furnished some most interesting additions to the Burgess shale flora and fauna. A fossil similar to the graptolite Dictyonema proved a seaweed with a reticulate system of strengthening ribs of the thallus, which alone remain on maceration. Another fossil is a hydrozoan, belonging to the Hydroid Coelenterata, with distinct thecae. A small, black, leaf-like fossil was found to be a cystid of such primitive structure that it may be near the roots of the phylum of echinoderms. A fossil looking like a well-known branching graptolite is instead a crustacean with enormously developed many-branched swimming limbs, that in appearance is an overgrown nauplius of the present crustaceans, thereby indicating its ancestral character. Finally the fossil Marrella that was considered a bizarre crustacean with two pairs of gigantic horn-like appendages of the carapace was recognized as a freshly moulted trilobite neolenus. Its dorsal tests are still so thin that the delicate structure of the underside of the body is visible. These finds indicate that treasures are still buried in the ancient Burgess shale.

Bearing of Titanothere researches on the principles of mechanical evolution (to be printed in SCIENCE): HENRY FAIRFIELD OSBORN.

The third dimension in Yellowstone Park (illustrated): ARTHUR L. DAY.

Iron-bacteria in silicified bog-iron deposits of Cambro-Ordovician age: DAVID WHITE. Specimens of silicified limonite from the Jonesboro formation, of Cambro-Ordovician age, in Virginia, are found, when examined by means of thin sections under the microscope, to be petrified bog ore deposits in which several kinds of bacteria and algae are present in rather remarkable preservation. Among the plants, which appear golden yellow in the section, are forms closely resembling bog-iron depositing bacteria of the present day, such as *Siderocapsa* and *Crenothrix*, together with a representative of a low order of algae. The petrographic character of the deposit, which presents some notable crystallographic features, has been described by Dr. M. I. Goldman.

The peptide linkage in proteins: WILDER D. BANCROFT. The simplest way in which two amino-acids can condense gives the group —CONH—, which is known as the peptide linkage. Emil Fischer assumed that this was the most important linkage in the proteins and did an immense amount of work in synthesizing polypeptides. We have found that a solid containing the peptide linkage will apparently always add hydrogen chloride gas stoichiometrically to form the group —CONH(HCl)—. We have also found that hydrogen chloride gas is not taken up stoichiometrically by any of the nitrogens in zein, from which it appears to follow that there are no peptide linkages in zein. If there are no peptide linkages in zein, it becomes an interesting question as to what percentage of peptide linkages there may be in other proteins such as edestin and gliadin. The first question to tackle is, of course, what the nitrogen linkages are in zein.

The structure of some sodium and calcium alumino-silicates: Linus Pauling (introduced by A. A. Noyes). With the use of the set of structural principles recently developed, the structures of the minerals natrolite, $Na_2Al_2Si_3O_{10} \cdot 2H_2O$, the scapolites (of which the end members are marialite, $Na_4Al_3Si_9O_{24}Cl$, and meionite, $Ca_4Al_6Si_6O_{24}(SO_4, CO_3)$), and davynite-cancrinite, $(Na, Ca)_4Al_3Si_3O_{12}(CO_3, SO_4, Cl)$, have been determined. In each case the crystals consist of a framework of AlO_4 and SiO_4 tetrahedra joined by the sharing of oxygen ions at tetrahedron corners. Within the framework there are cavities which are occupied by sodium or calcium ions, larger negative ions and water molecules or other groups, which can be removed or replaced by other ions or molecules without destroying the framework. The structures account for the characteristic phenomena of base exchange and of dehydration and rehydration (of zeolites) shown by the substances.

Synthesis of d-mannoketoheptose: C. S. Hudson and Edna M. Montgomery.

Isolation of four forms of d-mannoheptose: C. S. Hudson and Edna M. Montgomery.

Interaction of nitrogen trichloride and nitric oxide at −150°; further evidence for the formation of nitrogen dichloride and of mono-oxygen-di-nitrogen-dichloride: William Albert Noyes. In a paper published two years ago it was shown that at −80° two mols of nitric oxide react with one mol of nitrogen trichloride, giving one mol of nitrosyl chloride, one of nitrous oxide and one atom of chlorine. This was explained by assuming that the primary reaction gives nitrosyl chloride and nitrogen dichloride and that the latter immediately combines with nitric oxide to give mono-oxygen-di-nitrogen-dichloride, $ON—NCl_2$. The reaction has now been carried out at −150°, the boiling-point of nitric oxide. At this temperature, three mols of nitric oxide react with the trichloride, giving two mols of nitrosyl chloride, one of nitrous oxide and one atom of chlorine. The simplest explanation of this result seems to be that the mono-oxygen-di-nitrogen-dichloride is sufficiently stable at −150° to permit a third mol of nitric oxide to take from it one atom of chlorine. Either at that temperature or on warming up, the mono-oxygen-di-nitrogen-monochloride decomposes to nitrous oxide and chlorine.

Diazocamphene from bornylamine and from neo-bornylamine: William Albert Noyes and Ulrich Heubaum. Forster and others have shown that two bornyl amines are formed by the reduction of camphor oxime, normal bornyl amine and neo-bornylamine. These are optical isomers, because of the asymmetry of the carbon atom to which the amino group is attached. From these amines the two urethanes and their nitroso derivatives have been prepared. By the action of sodium methylate on the nitroso derivatives of the urethanes, at a low temperature, the corresponding diazo compounds have been made. These compounds are even more unstable than the diazo compounds prepared by Kendall and Noyes. Their specific rotation and rotary dispersion were determined, approximately, however. They have a high rotation and an extraordinary rotary dispersion, with a maximum in the green, similar to those obtained by Kendall for the diazo compounds from the amino-camphonanic acids. It has not been possible to show a difference in the specific rotations of the two compounds, probably because of the difficulty of exact measurements with such unstable, colored compounds. Mr. Ray, of Grinnell, has, however, shown that the two diazo compounds prepared by Kendall give different decomposition products, demonstrating that the carbon atom combined with the diazo group is asymmetric.

The effect of low temperatures on the sensitivity of radiometers: Sinclair Smith (introduced by George E. Hale). The sensitivity of a radiometer at the temperature of liquid air was compared with that of the same radiometer at room temperature. Curves were derived for both temperatures which show the change in sensitivity with pressure for the same radiometer in hydrogen, helium and air. In these gases, at the lower temperature the maximum sensitivity is increased and shifted towards lower pressures. The form of the pressure-sensitivity curve remains unchanged.

The crystal clock: W. A. Marrison (introduced by F. B. Jewett). A quartz crystal may be used as the rate controlling element in an accurate clock. From the standpoint of stability, crystalline quartz has some inherent advantages over all other materials for this use. A clock system based on a short period vibration such as is obtained from a quartz crystal oscillator has many advantages over conventional systems for making time comparisons. These include means for intercomparing separate systems, means for measuring short time intervals accurately and means for producing time signals electrically as accurately as the absolute time can be determined. The dial setting and the rate of a crystal clock may be changed by continuous adjustments without in any other way affecting the time-keeping qualities of the system. The rate of the crystal is not affected by magnetic fields or changes in g, and to only a small extent by earth vibrations. Clocks may be operated at different rates from the same rate controlling element. In particular a mean solar clock and a sidereal clock can be operated from a single crystal and rated so that the error in the ratio of the rates is less than one second in a century. Accurate mean solar and sidereal seconds timing pulses may be obtained electrically from the respective mechanisms.

Analysis of the growth curve of man: Franz Boas. Our knowledge of growth is based essentially upon measurements of groups of children of varying ages. The following observations are based on the study of individual growth curves. The acceleration of rate of growth of boys during adolescence occurs at varying times, between eleven and seventeen years. Boys who show the most rapid rate of growth at an early time pass through the whole developmental period with greatest rapidity. They have a higher rate of growth at this period than any other group, and their total increase during a period beginning three years before and ending three years after the period of most rapid growth is greatest. The material available at the present time does not show any appreciable influence of the difference in period of most rapid growth upon the average stature of the adults. Even those who have their maximum rate of growth at the same time vary in the extent of the growth period; among some it closes soon after the period of maximum rate of growth; among others it extends over several years. It is probably due to this fact that the variability of stature of slowly maturing groups of boys is greatest. The increase of variability, which is characteristic of growing boys taken *en masse*, disappears for the group whose maximum rate of growth is between thirteen and fourteen years. For all the others the increase of variability is much reduced. The data available at the present time also suggest that adults who have developed slowly are more variable than adults who have developed rapidly. This may be an expression of a more intensive influence of environmental conditions favoring or inhibiting growth.

An archeological research and its ramifications: A. V. Kidder and S. G. Morley (introduced by John C. Merriam). In order to interpret in terms of history the archeological data emanating from investigations by Carnegie Institution of Washington in the Maya field, it is necessary to call upon botanists, zoologists, geologists and meteorologists for information regarding environmental factors, and upon medical men and physical anthropologists for information as to biological aspects of man. Cooperations have been established with workers in certain of the above sciences and enlistment of aid from others is contemplated. Work accomplished to date reveals problems of special interest to individual sciences and of general significance to larger groups. The interrelation of the studies is considered, and it is pointed out that coordinated effort not only is necessary for solving the complex questions of human history but also serves as a practical method of forming contacts between diverse branches of natural science.

Concentration of remnants of Indian tribes in northwestern California: C. Hart Merriam. Probably no part of the United States is so little known from the standpoint of its aboriginal inhabitants as a small area in the mountains of northwestern California—an area restricted to the drainage basins of the Salmon and New Rivers with adjacent parts of the main Trinity and its South Fork. Within a radius of forty miles from Hoopa Valley there were in whole or in part the home lands of nineteen tribes of Indians, representing eight linguistic stocks. It is doubtful if in any other part of the world there are in so small an area so many tribes speaking different languages. Most of these tribes are fairly well known, but during the mining days of the fifties and early sixties several of them were practically exterminated by the onrush of gold seekers and the troops called in to help. Indeed, so complete was the destruction that in the case of four of the tribes the few survivors succeeded so well in remaining hidden from inquisitive eyes that not even the names of the tribes were ascertained by anthropologists.

A remarkable case of word borrowing among California Indians: C. Hart Merriam. Work among the Shoshonean tribes on both sides of the Nevada-California boundary south of the latitude of Mono Lake has brought to light a surprising if not unique case of the borrowing of words, particularly the names of animals. These names as used by the Monache of Owens Valley, on the east side of the Sierra, disagree almost wholly with the names used by their relatives only a short distance farther north—the "Northern Piute" bands of Mono, Walker and Pyramid Lakes. Further study has shown that the un-Shoshonean names of the Owens Valley Monache are in current use among the several derivative Monache tribes on the west side of the Sierra. These names, that differ from those of the "Northern Piute," agree essentially with those of an unrelated stock, namely, the Yokut, of San Joaquin Valley. In other words, a series of tribes of Shoshonean stock have set aside the animal names in common use among their near relatives and have replaced them by the names used by several tribes of a widely different linguistic stock—the Yokut. So far as I am aware, no parallel is known.

The theory of specific skills in musical training: C. E. Seashore. The theory that success in musical performance, either vocal or instrumental, is conditioned upon the early mastery of a few fundamental skills was advanced. Methods of developing these skills by instrumental aids in intensive training were illustrated and the instruments needed for such training were shown. Among these were the rhythm meter, the tone dynamometer, the tonoscope, the projectoscope and the piano camera, all instruments designed and built in the psychological laboratory of the University of Iowa.

BOOKS RECEIVED

Berry, Pauline G. *Stuff: The Story of Materials in the Service of Man.* Pp. xiii + 504. Illustrated. Appleton. $5.00.

Clark, Austin H. *The New Evolution: Zoogenesis.* Pp. xiv + 297. Illustrated. Williams and Wilkins. $3.00.

Garrett, Henry E. *Great Experiments in Psychology.* Pp. xvii + 337. 11 plates. 35 figures. Century.

Jastrow, Joseph. *Piloting Your Life.* Pp. xvi + 372. Greenberg. $3.50.

Parsons, T. R. *The Materials of Life:* A General Presentation of Biochemistry. Pp. 288. 8 illustrations. Norton. $3.00.

Scott, George G. *The Science of Biology:* An Introductory Study. (Revised edition.) Pp. xx + 633. 390 figures. Thomas Y. Crowell. $3.75.

Worsnop, B. L. *X-Rays.* Pp. ix + 101. 36 figures. Dutton. $1.10.

Young, John W. *Projective Geometry.* The Carus Monograph Series. No. 4. Pp. ix + 185. 65 figures. Open Court.

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THE MEANING OF THE CRYSTAL[1]

By Sir WILLIAM HENRY BRAGG

DIRECTOR OF THE ROYAL INSTITUTION OF GREAT BRITAIN

In the time which is allotted to me I should like to explain, if my audience will allow, the scope of the work in which, with my son and others, I have been recently engaged. I must first beg to remind you of certain facts. The elements of construction of the universe are the atoms, of ninety-two different kinds. The first constructive step is the assembling of the atoms into molecules. A molecule is a company of atoms in an association, which has some permanence great or small. The number of kinds of molecules is enormous. The water molecules consist of two atoms of hydrogen and one of oxygen. The molecule of ordinary salt contains one atom of chlorine and one of sodium; the molecule of an organic substance is generally more complicated, as, for example, that of naphthalene, which contains ten atoms of carbon and eight of hydrogen. If the atoms are likened to the letters of the alphabet, the molecules must be compared to words.

The next step in nature's architecture is the linking of molecules to form solid substances, such as the subjects which we see around us and ourselves. The properties of all substances depend upon the way the molecules are put together, just as a house, or its interior, has a character and a usefulness, which depend upon its design, or just as the meaning of a sentence depends on the words it contains and on the way they are arranged.

This second step is not always made: the hindrance to its accomplishment is heat. Heat is a mode of motion. When, for example, the molecules of water are set in very rapid motion by imparting sufficient heat to them, the forces that would make them combine are overcome; the molecules exist as independent individuals and we have water vapor or steam. With less heat and less motion the molecules are always in partnership, but always changing partners, and we have water. Still less heat, and the molecules become permanently attached to each other in unchanging positions, and thus ice is formed. Some molecules feel heat more than others, so that at ordinary temperatures some substances are solid, some liquid, and some are gases.

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[1] Medal Day address, delivered at the Franklin Institute, Philadelphia, Pa., on May 21.

It is the great aim of scientific research to connect the properties of a substance with the design of its construction. Gases have the simplest design, and the laws of gases are fairly well understood. Liquids come next, and we know something of their laws also. In particular we have learned much of what happens when liquids of different kinds are mixed together; we have watched when molecules pull each other to pieces and make molecules of new patterns out of the old. This is the province of science which we call chemistry. The enormous advances in pure and applied science, for which chemistry is responsible, show how great are the results of research even in this limited field.

But when we come to solids we have to admit that we know very little indeed of the way in which their properties depend on their composition. The fact is that their properties depend on the arrangement of the molecules; these now have definite positions, and the pattern of the arrangement is all important. There was very little of this in liquids and none at all in gases. To make headway we must therefore learn the laws of arrangement. Until recently this has not been possible, and we have been unable to enter a field of research which may well turn out to be the richest of all fields. But the X-rays have now opened the door for us; let me briefly explain how.

I must first say a few words about the capacities of our eyes. It is a strange fact that the eyes of men can see only a minute fraction of the things and the happenings that surround them. The light which brings us our knowledge—daylight, artificial light or lamplight—is narrowly limited in quality, and on that account tells us only a small part of the whole tale. We are accustomed to recognize differences in quality. We speak of red, green, blue and indeed of an infinite variety of shades. The student of physics estimates their differences by reference to the standard of wave-lengths, the waves referred to having their being in a hypothetical medium called the ether. He is not quite sure, in these days, of the amount of reality which should be assigned to these waves, but that is of far less importance than it sounds. The ether and its wave-length furnish for us a most useful language in which to express our thought and measurement. It then appears that the length of the ether waves may lie anywhere between very wide limits. In vision we use a minute section of that range. If we had never found any other means of detecting ether waves except our eyes, we might never have known the limits to our knowledge. But now, as I may remind you, we use very long invisible waves for transmission by radio, and, quite frequently, short invisible rays for the purposes of photography.

Now the quality or wave-length of the light determines what we can see by its means. Small details can be made out by short waves, and become less distinct if the light is of longer wave-length. Even within the narrow range of vision this difference can be observed. In certain microscopes used by biologists only light of extremely small wave-length is employed, the smallest that can be brought to bear upon the photographic plate, or the human retina, and in this way the power of the microscope is extended. On the other hand, it is curious to observe what a difficulty there is in picking up details in a red light, although the wave-length is only twice that of the shortest visible blue.

This strange limitation surely prompts our inquiry as to the reason, if one can be given. It is a fact that waves shorter than the visible cannot penetrate the miles of the atmosphere, so that even if our eyes could see them they would have no use for their powers. If our eyes responded to waves much longer than the normal we should certainly miss much detail that we value. Again it is a fact, of an entirely different bearing, that the perception of light depends on a curious process in which electrons are shifted out of their usual positions in the atoms of the retina. Now the shifting cannot be accomplished if the wave-length of the light is more than about a thousand times longer than the diameter of the atom. As atoms of all sorts have sizes which do not differ widely among themselves, a certain limit is set to the light which the eye, as constituted, can detect. The waves must not exceed a certain length. Since the eyes of all creatures are made and act in much the same way, that which is light to one is light to all. Sir John Lubbock thought that ants could see blue light better than red, and I have seen it stated that certain insects do not appreciate light that has come through yellow glass. Whether these are actual facts or not, it is certain that the range of vision is very small. I do not know that any of these considerations answer the question, why? Mathematicians tell us that a ray of light, the emblem of directness, in continuing its way through space will in time return to where it began, and if we seek to distinguish between cause and effect, we are apt, proceeding step by step, to be in much the same case and to find that the last effect is also the first cause.

The consequence of the limitation is a corresponding restriction of the visible world. We are normally unconscious of all but a fraction of our surroundings.

We have tried to extend our powers. We have first made use of the simple lens, then of the microscope, trying by these means to give to our eyes the more extended use of the light waves that can be seen. But to this effort there is a limit. When the optician has done his wonderful best, and when the shortest light waves are used, there is necessarily a halt; and at one time it seemed that the halt must be a permanent stop. But what new worlds, or rather new comprehensions of the old world, have been opened up by these means alone! We are so accustomed now to the new vision that we have forgotten how strange it must have been to the early users of its powers. When Hooke wrote his "Micrographia" in the middle of the seventeenth century he was in a mood of amazement at what the newly invented microscope told him. Section after section of this fascinating book describes the wonderful and hitherto invisible details of common objects—a hair, a piece of silk, a needle point and so forth. No doubt there were those who thought that these incursions into a new world of knowledge were unjustifiable, and what the eye could not see naturally was not worth seeing, and was not intended to be seen. We have learned that these minute things and happenings affect deeply and immediately our health and happiness and our ability to use the resources of nature. And every improvement in the use of ordinary light by the microscope has added to our realization of the infinite and the unity of nature.

But as I have said, where we have made use of ordinary light, we come to a dead stop in this direction. It is here that X-rays, being what they are, furnish us unexpectedly and magnificently with a new range of vision. Consisting of ether waves, in the same sense that light so consists, but being some ten thousand times shorter, they can take note of details which are far finer than light can show us. It is very important to realize that minuteness does not mean insignificance or want of relation to ourselves. The world which they can portray is as full of richness and variety, movement and interest as that which we see normally. It is true that our eyes see none of it, and so it is not associated with the ideas of beauty in form and colors. We cannot thoughtlessly take pleasure in it, as we may in the other. We must grasp what the X-rays tell us by means of delicate and complicated scientific methods, and our admiration and interest are of the mind only.

What sort of things do we now perceive? We see, if I may use the word in a broad sense, that arrangement of atoms and molecules in the solid body, of which we have been so eager to obtain knowledge. We stand in front of nature's architecture and examine her use of the elements in her construction. And here I must speak of a very important matter. We should still be unsuccessful did we not avail ourselves of one of nature's most remarkable characteristics, one which we have not indeed fully appreciated until now. It is her extraordinary tendency to regularity and order. If it were not for this uniformity, even the new rays could not help us. The effect of a single atom upon X-rays is far too small to detect. The effect is there, as it would not be with visible light, but it is insufficient in quality. But nature arranges her atoms in regular order in millions of millions, and the combined effect is big enough to affect our instruments. It is just as when the wind turns over all the leaves of the poplar tree at the same moment and the whole tree appears silvery gray, and so we learn what we could not have observed from the behavior of a single leaf. A more exact analogy is found in certain colorations of nature, in the hues of butterflies, for example, where a regular assemblage of fine scales makes for color, though each scale is too minute to be visible.

We see, for example, the atoms of carbon in the diamond and their perfect alignment according to a simple plan which gives every atom four other atoms as neighbors equally and regularly spaced about the first. We begin to understand how the design gives the diamond its unique hardness. We see the carbon atoms rearranging themselves according to a new plan to make the soft and slippery graphite. We see the atoms of oxygen, which far exceed all others in number, drawn up in regular order like a pile of shot to form the structure of most of the earth, and held together by atoms of silicon, magnesium, aluminum and so forth. The beautiful forms of the crystals of snow and ice are observed to be derived from the underlying and particular arrangement of the oxygen and hydrogen atoms. We begin to understand the details of construction of those long chains of certain atoms which are of such tremendous importance in the construction of living organisms. It is not to be forgotten that chemical investigation has long made us aware of their existence, but now we see, I think it is fair to say, what hitherto we have only inferred. We get a first rough idea of the actual forms of those curious hexagonal rings of carbon (the benzene ring) which are also of first importance to living things, and in other structures are the basis of dyes and many other great classes of compounds. It is indeed the whole range of nature's first compiling of atoms and molecules to form ourselves and the things about us that now opens to our view. Our untrained eyes do not yet interpret all, even a small fraction of what they see. But as results accumulate and workers grow in number and power, so at the same time our interpretation becomes more accurate and effective. There is infinite opportunity for research, first of all in description of what the X-ray reveals, just as Hooke disclosed what the microscope told him, and then the greater and even wider enterprise of connecting the structure of bodies with the properties which they possess. You will understand the fascination of this new field of research.

A MOMENTOUS HOUR AT PANAMA[1]

By Dr. JOHN FRANK STEVENS

FORMER CHIEF ENGINEER, THE PANAMA CANAL

There has been published from time to time such a mass of information about the Panama Canal, a project which aroused much controversy a quarter of a century ago, that any reference to it after the lapse of years may seem to be quite superfluous; but as is often the case in human affairs, history does not always record events which have had a profound influence for good or evil upon the solution of the problems involved. The history of the planning and construction of the Panama Canal is no exception to such general rule.

The condition of affairs on the isthmus during a part of the year 1905 can truly be described as desperate; by many well-wishers even it was regarded as hopeless. When the speaker arrived there in July of that year, he found not even the skeleton of a general organization. Supreme authority was vested in no one. The Sanitary Department was the only one having the semblance of a proper organization, and it was doing a limited amount of work under what would probably have proved a fatal handicap had it continued. The usual tropical diseases were prevalent, and that scourge of the white race, yellow fever, was taking its deadly toll daily. While the situation was in some degree psychologic, the danger was great, enough so that unless the disease was promptly checked and thereafter held under control, the success of the great enterprise would be jeopardized.

The tragic story of the French attempt to build a canal there was in many mouths, and predictions were freely made that the history of the Americans on the isthmus would be a repetition of the De Lesseps failure. Under the then existing conditions it would not have been possible to hold the small force of clerical and skilled white labor which had been collected, much less to induce thousands of other whites to enter the service. Especially so in view of the pessimistic attitude which some of the American press had taken, and the exaggerated accounts which they were publishing as to living and health conditions on the isthmus, some influential members openly advocating that the whole undertaking should be abandoned as affording no hope of a successful outcome.

At that time few of the general public knew anything of the so-called mosquito theory of the transmission of yellow fever, and they mostly regarded it as purely theoretical. Not so with the medical scientists who had successfully demonstrated it in Cuba, and of those scientists was Colonel William C. Gorgas, of the Medical Corps of the Army, who was the head of the Sanitary Department on the isthmus. He was working intelligently with a small but efficient staff, but with an utter lack of cooperation on the part of his immediate superiors. He was one of the first officials that I met there, and from him I gained my real insight into the famous theory.

Of Colonel (later General) Gorgas, his work and supreme service to mankind, it is unnecessary to speak here. His memory is so deeply cherished and his fame is so secure that no words of mine can add to either. Best of all, he was a kindly, sincere man, the highest type of gentleman, and I am proud to have known him, not only officially, but also as a warm friend.

The then chairman of the Isthmian Canal Commission accompanied me on my first visit to the isthmus, remaining there but five days, as the situation did not appeal to him. At that time Colonel Gorgas was reporting to the governor of the Canal Zone. Neither the governor nor the chairman had the least faith in the efficacy of the mosquito theory—at least they so emphatically advised me at once, and their actions confirmed their words.

Quoting from a brochure of General Gorgas's life and activities, written by the president of the American College of Surgeons:

> Finally, in June, 1905, the governor and chief engineer [my predecessor], members of the executive committee of the commission, united in a recommendation to the Secretary of War that the Chief Sanitary Officer (Colonel Gorgas) and those who believed with him in the mosquito theory should be relieved, and men with more practical views be appointed in their stead. They stated that the sanitary authorities had visionary ideas with regard to the cause of yellow fever, and no practical methods even of carrying them into effect.

The President declared his faith in the theory and directed that every possible support and assistance be extended to the sanitary officials. Personally, I have no knowledge except from hearsay of the accuracy of these statements, although I believe them to be true. What I *do* know is that such directions were not carried out either in letter or spirit.

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[1] Medal Day address, delivered at the Franklin Institute, Philadelphia, Pa., on May 21.

Quoting again from the same authority:

> About this time Mr. John F. Stevens was appointed chief engineer of the commission, and he recommended that the Sanitary Department should be made an independent bureau and report directly to himself. This enabled Colonel Gorgas to make known his needs directly to the highest authority, and there he was accorded loyal support. This, remarks Gorgas, was the high-water mark of sanitary efficiency on the isthmus, and more sanitation was done at this time than during any other period of the construction of the canal.

Incidentally, I may here remark that on my recommendation some time afterward the President appointed Gorgas as a member of the Isthmian Canal Commission.

However, these results were not achieved without a sharp controversy, during which the chief engineer clashed sharply with the chairman and the governor. I had been very deeply impressed by my conferences with Colonel Gorgas as to the probable truth of the mosquito theory, as well as by his personality. I also felt well assured that no canal could be built at Panama until the specter of yellow fever had been laid. There was no other promise of relief in sight than that of Gorgas and the mosquito theory, and there seemed to be but one course to follow.

On the occasion of a trip over the Panama Railroad, accompanied by the chairman and the governor, the sanitary work which was in progress, visible from the train, such as drainage of pools of water, applying oil where drainage was not practicable, fumigation of houses, etc., was pointed out to me in great detail by these officials, accompanied by constant ridicule, not only of Colonel Gorgas but also of the mosquito theory, some of these comments reflecting very severely upon the quality of the colonel's mental equipment.

My attention was repeatedly called to the great waste of money and the utter futility of the whole procedure. It became very apparent that a serious situation existed, and I was in a quandary as to how it could be met, as I well knew that it must be or a total collapse was inevitable. The climax came quickly.

The day before the chairman sailed for the States he advised me that he and the governor had decided that Colonel Gorgas must be gotten rid of (in his precise language, that he would "fire" him), and the mosquito theory, also. Some quick thinking and an important decision were needed on my part, which decision I proclaimed in rather heated language, not to be repeated here. At the close of my harangue, I said that if there seemed to be the least likelihood of approval of his action being given by the President (which I did not believe possible) I should take the matter in person to Washington; and that if Colonel Gorgas were removed I should not come back to the isthmus.

I asked him what he thought the reaction would be from the doubtful ones, and from the already unfriendly press, if it became known that the commission had urged the abandonment of the mosquito theory and the disruption of the Sanitary Department, and stated that, furthermore, if after a hasty visit to the isthmus the new chief engineer had, by his action, indicated his belief that the construction of the canal was impossible, it would mean chaos, whatever attitude the President might take. If it did not kill the project it would certainly delay it, and the end no man could foresee. He left for the States without further comment on the matter. If he urged his views in Washington (which I do not believe he did) I was never advised, and so the matter ended there, as it should.

I was seeking a way to stabilize the situation, for it was no time to be rocking the boat. Opportunity must be given for the Sanitary Department to prove its faith by its works, which I believed it could do.

It was not a question of Colonel Gorgas's business ability, but one of making the isthmus a safe place for white people to live and work in, and that quickly, regardless of whatever cost in mere money might be involved. Beyond doubt those officials were sincere in their opinions, but in my judgment they were wrong.

It was after this occurrence that Colonel Gorgas began to report to me, and from that time forward harmony prevailed. The Sanitary Department was furnished with everything it asked for as fast as it could be provided, and every other activity was made subordinate to its needs. Sanitary success soon became so apparent, coincident with the creation of a general organization, that carping criticism was practically stilled, for the first time since the American occupation of the isthmus. Science had scored a wonderful triumph over a deadly foe to the human race.

Sanitation was fundamental, and the success which the Sanitary Department achieved under Colonel Gorgas made the Panama Canal possible. When the result of its work became manifest, and when the lock type had been adopted, then the successful construction of the canal was as well assured, early in 1906, as it was on that historic opening day in August, 1914, when the steamship *Ancon* passed through it from ocean to ocean.

At this distance of time and space the episodes related may seem trivial. Only one who was on the ground, charged with tremendous responsibilities, can comprehend the magnitude of the issues at stake. A rejection of the mosquito theory at that juncture would probably have meant the indefinite postponement of the canal project.

I have said that I did not then deem it possible that President Roosevelt would uphold the elimination of Colonel Gorgas, but an occurrence which took place some years later gave me food for thought. Some time after Mr. Taft had become President, Colonel Roosevelt sent me an invitation to call upon him, which I did at the office of the *Outlook* magazine in New York. After some preliminary talk he told me that friction among officials on the canal had reached such a point that changes would have to be made, and that he thought Colonel Gorgas would have to go. He said that he was well aware that I knew more of Gorgas and his work than any man, and asked if in my opinion he should be kept.

It is needless to repeat what I told him. It was emphatic and to the point, and I closed by saying that if Gorgas were removed it would be a stupid blunder. Colonel Roosevelt pounded the desk in his usual vehement manner and exclaimed, "That settles it; Gorgas stays." Which he did, through what influences one can only conjecture.

I have thought, since that time, that possibly it was just as well that the issue was not raised to a finality in July, 1905. I had reason to know that the President then had great confidence in the chairman, but the status of the chief engineer in that respect had yet to be demonstrated. I did not have faith enough in the result to wish the matter put to a test.

In the year 1914, when Gorgas was Surgeon-General, I received a letter from him, reading in part as follows:

> I have a very clear and grateful recollection of the support and friendship you always gave me on the isthmus. I knew very well that you were the only one of the chief officials who believed in the sanitary work we were doing, and who was not taking active measures to oppose us. The fact is that you are the only one of the higher officials on the isthmus who always supported the Sanitary Department, and I mean this to apply to the whole ten years, both before and after your time, so you can understand that our relations, yours and mine, stand out in my memory of the very trying ten years I spent on the isthmus as a green and pleasant oasis.

Only fragmentary accounts of these episodes have ever been related, and as now that every one of those officials who were directly concerned with them, President, Secretary of War, governor, General Gorgas—every one excepting myself—has passed beyond the sphere of human activities, it seems fitting that while first-hand knowledge of the matters then at issue is yet available, it should become a part of the history of the construction of the canal, for it is not believed that the full significance of these events has ever been appreciated.

SCIENTIFIC EVENTS

TROPICAL DISEASES EXHIBIT AT ANTWERP

ACCORDING to *The British Medical Journal* the Antwerp Exhibition was opened by the King of the Belgians on April 26. The Tropical Diseases Section, in the British Government Building, was organized under the auspices of the Exhibitions Branch of the Board of Trade, and is under the direction of a committee, of which Major-General Sir Wilfred Beveridge is chairman. The exhibit has been designed to impress upon the general public the importance of knowledge of health matters to those who live under tropical conditions. It also depicts certain dangers and the means by which they may be combated. A complete outline of thirteen important tropical diseases is presented by means of serial illuminated pictures, illustrating the causation, manifestations, treatment and prevention of each disease. Above each series are placed enlarged photographs of work which has been carried out in connection with the disease under consideration. Above these photographs are illuminated statistics showing the beneficial results to the community of such preventive treatment. The organisms responsible for various tropical diseases—protozoa, helminths and bacteria—are demonstrated by color photomicrography in six specially constructed viewing cases. Some of the diseases are dealt with in greater detail in six cases prepared and lent by the Liverpool School of Tropical Medicine, and several excellent wax models of the insect vectors of diseases are shown. Enlarged photographs have been prepared of men who have laid down their lives in the investigation of diseases prevalent in tropical countries; this exhibit indicates the special dangers attaching to research work in yellow fever and typhus. A model of the new London School of Hygiene and Tropical Medicine, taken in conjunction with the Liverpool School exhibit, emphasizes the fact that the importance of education in tropical medicine is recognised. The care of those suffering from tropical diseases is largely in the hands of the Seamen's Hospital Society, which has prepared an exhibit illustrating the work done by their hospitals. Two small historical exhibits are shown dealing with plague and leprosy in olden times. In the "Manson" exhibit the memory of the "Father of modern tropical medicine" is honored. The Wellcome Museum of Medical Science has been responsible for the detailed organization of the whole exhibit and also for the preparation of all transparencies, photomicrographs and statistics.

THE GERMAN ASSOCIATION OF SCIENTIFIC MEN AND PHYSICIANS

IT is stated in *Nature* that the German Association for Natural Science and Medicine has visited in recent years Innsbruck in the south, Düsseldorf in the west and Hamburg in the north. This year the association will proclaim science and civilization at Königsberg in the far east of Prussia. The invitation circular is not to members of the association alone, but also to all who honor German science, and makes welcome the participation of foreign savants who feel themselves in contact with German research. This ninety-first assembly of the "Gesellschaft Deutscher Naturforscher und Aerzte" takes place on September 7–11, 1930. There will be general addresses, a short program of sectional meetings and numerous joint discussions. Festivities are to be limited in favor of the call of learning. The main topics include protoplasm, bird migration, logic and natural science, the natural system of the elements, agriculture and economics. The medical side will discuss blood pigments and bacteria, and will combine with biologists to discuss inheritance and with physicists to consider the eye. Joint discussions will deal with the cosmic frequency of the elements, the age of the earth, the synthesis of silicates and cosmic radiation. Botanists and agriculturalists will discuss meteorology. Various allied scientific societies are holding their meetings at the same time and place. The program of excursions includes the neighboring sand-dunes, lagoons, bathing-resorts, fresh-water lakes and historic monuments. Longer journeys include Finland for mineralogists before the meeting, and after the meeting Leningrad and Moscow. Königsberg can be reached from Berlin without any further visa, passport or tax; eight times daily by train in 9–10 hours; by fast motor-ship *via* Swinemünde-Zoppot-Pillau, 18 hours at sea; also thrice daily by air in 4–5 hours. The subscription for those attending the meetings, but not regular members, is 25 rm.; applications should be sent to Secretary G.D.N.A., Professor Dr. Rassow, Leipzig C.1, Gustav-Adolfstr. 12, and if possible by mid-May by those wishing to join excursions.

A GOVERNMENT GAME RESERVATION

A SPECIAL correspondent of *The Christian Science Monitor* reports that if proposed legislation now before the House of Representatives is passed, a great game preserve capable of providing food and resting places for more than 200,000 birds at one time and of producing more than 1,000,000 in a year will be added to the national reserves of the United States government.

The Senate has already passed a bill providing for the expenditure of $300,000 for the purchase of the shallow lake which has since 1927 covered a barren area of about 20,000 acres in Barton County, Kansas, known as the Cheyenne Bottoms. Mr. Clifford R. Hope, representative from Kansas, is reported to have said that with the support which the Department of Agriculture has indirectly given to the bill its passage is assured.

Adherents of the measure point out that the Cheyenne Bottoms are situated in the path of the migrations from Alaska to the south. Banding of the birds has shown that those which frequent the Bottoms come from Alaska and many parts of Canada and go as far south as Yucatan. They come in thousands and in great variety.

Immediate action on the measure is necessary as efforts are being made by owners of the land over which the lake now flows to have it drained. They have an investment in the property and feel that some return can be obtained by its use for grazing if it can first be drained. In 1928 they formed a company for this purpose. Opposition of various societies and groups interested in the preservation of wild bird life was strong enough to procure an injunction against the drainage proceedings. But owners can not be permanently restrained from treating their property as they wish. Therefore the federal government is being approached in hope that the entire district may be purchased and formed into a migratory bird reserve.

If obtained for the nation the Cheyenne Bottoms would be cared for under the provisions of the Norbeck-Anthony bill which furnishes appropriations for the work of the Biological Survey.

THE COAL RESEARCH LABORATORY OF THE CARNEGIE INSTITUTE OF TECHNOLOGY

GIFTS amounting to $425,000 to extend over a five-year period for the establishment and maintenance of a coal research laboratory at the Carnegie Institute of Technology have been announced by Dr. Thomas S. Baker, president of the institute.

The Buhl Foundation of Pittsburgh is the largest single donor to the project, contributing $50,000 at the outset for the equipment of the laboratory and $25,000 a year for five years for a program of pure research. The gift of the Buhl Foundation is made with the stipulation that certain additional amounts shall be secured from other sources. This condition has now been met through the cooperation of six great American firms. These are the United States Steel Corporation, the General Electric Company, the Koppers Company, the New York Edison Company, the Standard Oil Company of New Jersey and the Westinghouse Electric and Manufacturing Company. These six corporations will contribute a total amount of $50,000 a year for five years for the maintenance of the laboratory.

The laboratory will be located on the north side of Engineering Hall of the Carnegie Institute of Technology in a new wing constructed last summer. The plan for the new laboratory will go into effect July 1, 1930. The names of the director and members of the scientific staff will be announced soon.

The laboratory will be a part of the Carnegie Institute of Technology, and will undertake fundamental research in coal and the products which may be obtained from it. Graduate courses will be offered for the training of students in fuel technology in connection with the research laboratory, with the research staff giving instruction.

An advisory board, consisting of prominent men of affairs interested in coal research, will be appointed, to advise as to the general policies to be followed by the laboratory. A technical committee, including representatives of the companies that have contributed towards the support of the project, has been appointed to assist in selecting the staff and arranging the research program. This committee is composed of Dr. John Johnston, U. S. Steel Corporation, New York City; Mr. F. P. Wilson, Jr., General Electric Company, Schenectady, N. Y.; Dr. F. W. Sperr, Koppers Company, Pittsburgh; Mr. M. S. Sloan, New York Edison Company, New York City; Dr. Robert T. Haslam, Standard Oil Company of New Jersey, New York City; Mr. S. M. Kintner, Westinghouse Electric and Manufacturing Company, Pittsburgh, and Mr. Howard N. Eavenson, Eavenson, Alford and Hicks, Pittsburgh.

THE ADVISORY BOARD OF THE GUGGENHEIM MEMORIAL FOUNDATION

The trustees of the John Simon Guggenheim Memorial Foundation announce that the following-named persons have been appointed members of the foundation's advisory board: Dr. Isaiah Bowman, director of the American Geographical Society; Dr. Wilbur L. Cross, editor of the *Yale Review* and dean of the Graduate School of Yale University; James Earle Fraser, sculptor, and Dr. Marjorie Nicolson, professor of English and dean of Smith College. Miss Nicolson, a former fellow of the foundation, is the second fellow to be appointed a member of the advisory board. The first was Professor Arthur H. Compton, of the University of Chicago, who won the Nobel prize in physics in 1928.

The advisory board consists of the following persons in addition to those mentioned above:

Dr. Frank Aydelotte, president, Swarthmore College, *chairman*.
Dr. Tucker Brooke, professor of English, Yale University.
Dr. Henry Seidel Canby, editor, *Saturday Review of Literature*.
Dr. Edward Capps, professor of classics, Princeton University.
Dr. Ada Louise Comstock, president, Radcliffe College.
Professor William Emerson, head of the department of architecture, Massachusetts Institute of Technology.
Dr. Frederick Carlos Ferry, president, Hamilton College.
Dr. Guy Stanton Ford, dean of the graduate school, University of Minnesota.
Dr. Charles Homer Haskins, professor of history, Harvard University.
Dr. Vernon Kellogg, permanent secretary, National Research Council.
Dr. Fiske Kimball, director of the Pennsylvania Museum.
Dr. Charles B. Lipman, dean of the graduate division, University of California.
Dr. Lafayette B. Mendel, professor of physiological chemistry, Yale University.
Dr. John C. Merriam, president, Carnegie Institution of Washington.
Dr. James F. Norris, professor of organic chemistry, Massachusetts Institute of Technology.
Dr. Louise Pound, professor of English, University of Nebraska.
Mr. Thomas Whitney Surette, lecturer in music, Harvard University Graduate School of Education.
Dr. Edwin B. Wilson, professor of vital statistics, Harvard University School of Public Health.
Dr. F. J. E. Woodbridge, professor of philosophy, Columbia University.

Since the establishment of the foundation by former United States Senator and Mrs. Guggenheim five years ago, 295 fellowships have been awarded. The foundation is a memorial to a son of the founders and its purpose in the words of Senator Guggenheim's letter of gift is to "advance human achievement by aiding students to push forward the boundaries of understanding and enrich human life by aiding them in the cultivation of beauty and taste." In accordance with these purposes the foundation offers fellowships, normally of the value of $2,500 a year, tenable abroad under the freest possible conditions for research in any field of knowledge and for creative work in any of the fine arts. The fellowships are open to men and women, whether married or unmarried, of every race and creed, on equal terms. The foundation has a capital fund of $4,500,000.

The trustees of the foundation, in addition to the founders, are Francis H. Brownell, Carroll A. Wilson, Charles D. Hilles, Roger W. Straus and Charles Earl.

SCIENTIFIC NOTES AND NEWS

At the annual garden party of the New York Zoological Park on May 22 a bronze elephant, executed by the late Carl Akeley, was presented by Mr. Madison Grant on behalf of the executive committee to Professor Henry Fairfield Osborn as a token of his thirty-five years of service to the Zoological Society.

At the annual commencement of the University of California on May 14 Mr. F. H. Seares, astronomer and assistant director of the Mount Wilson Observatory, was awarded the honorary degree of doctor of laws.

At the forty-sixth commencement of the Case School of Applied Science on May 29 the doctorate of science was conferred on Dr. W. W. Coblentz, physicist, of the Bureau of Standards, and the doctorate of engineering on Mr. John Lyle Harrington, consulting bridge engineer, of Kansas City, Missouri. On Wednesday evening Dr. Coblentz addressed the Case chapter of the Society of Sigma Xi.

The Museums of the Peaceful Arts, the American Institute and the New York Electrical Society gave a luncheon at the Hotel Astor on May 27 in honor of Sir William Henry Bragg, Fullerian professor of chemistry and director of the Royal Institution, London, and of the Davy Faraday Research Laboratory.

At the recent annual general meeting of the British Chemical Society the prize and plaque to perpetuate the memory of Edward Frank Harrison, director of chemical warfare during the war, was presented to Dr. Reginald Patrick Linstead. This prize is awarded every three years to the chemist, not over 30 years of age, who is judged by a committee consisting of the presidents of the Chemical Society, the Society of Chemical Industry, the Pharmaceutical Society and the Institute of Chemistry to have made the most meritorious original contributions to chemical science during the previous five years. Professor J. F. Thorpe, president of the society, made the presentation.

Dr. Carl Leavitt Hubbs, curator of fishes in the museum of the University of Michigan and assistant professor in the department of zoology, has received the faculty award for a member of the teaching staff, not above the rank of assistant professor, who, in the opinion of a special committee of the university senate, has won special distinction in his field.

Dr. Harry N. Eaton, of Elmira College, was elected to succeed Professor Edward S. C. Smith, of Union College, as president of the New York State Geological Association at the recent Schenectady meeting. Professor O. D. von Engeln, of Cornell University, was elected secretary to succeed Professor Harold L. Alling, of Rochester University.

The Society for Experimental Biology and Medicine, New York City, has elected the following officers for the coming year: *President,* Peyton Rous; *vice-president,* D. J. Edwards; *secretary-treasurer,* A. J. Goldforb; *councillors,* Alfred E. Cohn, Leon J. Cole, C. F. Cori, A. B. D. Fortuyn, F. P. Gay, J. T. Halsey, A. C. Ivy, W. Ophüls, W. J. V. Osterhout, W. W. Palmer, F. H. Scott, H. D. Senior, P. A. Shaffer, F. M. Smith and G. B. Wallace.

Mr. G. A. Orth, executive of the American Car and Foundry Company and a member of the executive committee of the National Society of Safety Engineers, has been elected president of the New York chapter.

It is announced in *Nature* that Sir Ernest Rutherford, president of the Royal Society, has been appointed chairman of the Advisory Council of the Department of Scientific and Industrial Research in succession to Sir William McCormick as from October 1. Professor V. H. Blackman will serve as chairman until October.

Dr. R. G. Aitken, who has been in charge of the active administration of Lick Observatory since July 1, 1923, with the title of associate director, has been named director, the appointment to date from July 1.

Dr. W. A. Riley, at present head of the department of zoology at the University of Minnesota, will become chief of the division of entomology in the same institution on July 1, when R. N. Chapman leaves to become director of the Experiment Station at the University of Hawaii.

Professor Franz Schrader, of Bryn Mawr College, has been appointed professor of cytology in the department of zoology at Columbia University.

Professor R. Keith Cannan, of University College, London, has been appointed head of the department of biochemistry at the University and Bellevue Hospital Medical College, New York University. Professor Cannan was born in California. He has worked with Professor William Mansfield Clark in Washington and has taken part in teaching at Western Reserve University.

Dr. Nathan B. Eddy has resigned as associate professor of physiology and pharmacology at the University of Alberta to become associate professor of pharmacology at the University of Michigan.

The following promotions have been made at the University of Washington: Dr. John E. Guberlet, associate professor of zoology to a full professorship; Albert L. Seaman, from instructor in geology to assistant professor; Clinton L. Utterback, from assistant to associate professor of physics, and John Perry Ballantine from assistant to associate professor of mathematics.

Recent changes in and new appointments on the staffs of the Texas Agricultural Experiment Station and the Extension Service, Agricultural and Mechanical College of Texas, include J. N. Roney, division of entomology, Experiment Station, entomologist of the plant lice laboratory, Dickinson; S. E. Jones, entomologist of the Experiment Station, to succeed C. J. Todd, resigned to enter irrigation farming; H. P. Smith, for a number of years associate professor of agricultural engineering at the college, chief of the division of agricultural engineering in the Experiment Station.

Dr. Paul E. Weston has resigned as research chemist for the Roessler and Hasslacher Chemical Co., Perth Amboy, New Jersey, to accept a position as Senior Eli Lilly Research Fellow at Purdue University.

Dr. Horace B. English, professor of psychology at Antioch College, has accepted appointment as professor of psychology at Ohio State University. Dr. Clarence Leuba, lecturer in psychology at Bryn Mawr College, has been appointed associate professor of psychology at Antioch College in succession to Dr. English.

The J. T. Baker Chemical Company's fellowship in analytical chemistry, eastern division, has been awarded to Mr. Reuben Roseman, who will work at Johns Hopkins University under the direction of Professor W. M. Thornton, Jr., on a problem relating to the use of powerful reducing agents in volumetric analysis.

The regius chair of medicine in the University of Aberdeen, rendered vacant by the resignation of Professor Ashley Watson Mackintosh, has been filled by the appointment of Dr. Leybourne Stanley Patrick Davidson.

Professor F. Marion Lougee, of the department of chemistry, of Keuka College, who is on leave of absence for the semester, is engaged in research work at the University of London and will travel on the continent during the summer. Dr. Minnie A. Graham is in charge of the department during Dr. Lougee's absence.

Arthur Paul Jacot, of the department of biology of the Shantung Christian University, will spend the summer at the Marine Biological Laboratory of Sendai University, Asamuchi, northern Nippon, through the kindness of its director, Dr. Shinkishi Hatai, and a grant from the Elizabeth Thompson Science Fund, to study the moss-mites of the region and the scale characters of the mullets of those waters.

Dr. Aleš Hrdlička, of the U. S. National Museum, left Washington on May 5 for Alaska. This year's expedition will be devoted to the anthropologically practically unknown Kuskokwin River. Dr. C. E. Resser left on May 13 to resume his studies of the Cambrian stratigraphy of the Rocky Mountains. The first two weeks will be spent in the Grand Canyon, where in cooperation with the Carnegie Institution search for fossils in the pre-Cambrian strata will be made. Mr. J. N. B. Hewitt left on May 10 to continue his researches on the Iroquois, and Dr. F. H. Roberts, Jr., of the Bureau of American Ethnology, left on May 12, for a point twenty-five miles southwest of Zuñi to excavate a series of pit house ruins belonging to the earliest stages of the prehistoric pueblo people.

Professor J. H. Ashworth, head of the department of zoology of the University of Edinburgh, gave a lecture at the University of Michigan, May 12, on "The Nervous System of Annelids in Relation to Movement." This lecture was under the auspices of the department of zoology.

Dr. Roger Adams, professor of organic chemistry and director of the department of chemistry of the University of Illinois, delivered the Charles E. Dohme Memorial Lectures at the Johns Hopkins University, School of Medicine, on May 1, 2 and 3. The subjects were: A Survey of Various Important Contributions of Organic Chemistry to Medicine; The Use of Chaulmoogra Oil, Chaulmoogric Acid and its Constitution; Synthetic Homologs and Analogs of Chaulmoogric Acid and their Bactericidal Action.

Dr. Raymond C. Moore, professor of geology in the University of Kansas, recently gave an illustrated lecture on the Grand Canyon of the Colorado in Arizona before an open meeting of the local chapter of Sigma Xi at the University of Nebraska.

THE annual address before the Virginia Chapter of Sigma Xi was delivered by Dr. C. E. McClung, professor of zoology, University of Pennsylvania, on May 16. At this meeting the President and Visitors' Research Prize of $100 was awarded for the best paper on research in the University of Virginia during 1929 to Dr. Carl C. Speidel, associate professor of anatomy, for his work on hyperthyroidism. At this meeting twenty new members were admitted to membership in the chapter.

DR. FRANK E. E. GERMANN was the guest speaker at the fortieth annual meeting of the Nebraska Academy of Sciences, meeting on May 9 and 10 under the auspices of the Peru State Teachers College, Nebraska. At the general session he spoke on "The Use of Physical and Physico-chemical Measurements in the Sciences" and at a joint session of the mathematicians, physicists and chemists on Saturday morning his subject was "Para Hydrogen."

THE twentieth meeting of the Australasian Association for the Advancement of Science was held in Brisbane during the week commencing May 28, under the presidency of Mr. E. C. Andrews, government geologist, Sydney. The local honorary secretary for the meeting is Dr. D. A. Herbert, the University, Brisbane.

ON May 3 and 4 the department of geology of Washington University, under the supervision of Vice-chancellor Walter E. McCourt, entertained the faculty and advanced students of the department of geology of the Missouri School of Mines at a luncheon and dinner. An opportunity was afforded for the visitors to go through the new geology building on the campus at Washington University and to take a short field trip in the vicinity of St. Louis. Those attending included Dr. and Mrs. C. L. Dake, Dr. H. A. Buehler, Dr. and Mrs. G. A. Muilenburg, Dr. and Mrs. J. Bridge and Dr. O. R. Grawe.

PLANS are being made at Northwestern University for a hospital at Chicago Avenue and Fairbanks Court, Chicago, which are said to be the culmination of more than eight years of negotiation for the complete reaffiliation of Wesley Memorial Hospital and Northwestern University. The main building of the new hospital, to be erected at a cost of $5,000,000, will be 18 stories in height and its tower will extend upward 12 more stories. It will have 600 beds. Its clinics, together with the existing facilities the university has in Passavant Hospital, will form on the McKinlock campus a complete medical center, capable of caring for almost 1,000 patients. The new hospital will be largely devoted to patients from salaried and wage-earning families, according to George W. Dixon, president of the board of trustees of Wesley Hospital. More than two thirds of the patients will be cared for at less than average cost, and many will be cared for free of charge. On the other hand, complete apartments, including three rooms, a kitchenette and bath, a heretofore unknown feature in hospital equipment, may be obtained during convalescence, at a cost of $100 a day.

THE dedication of the new central unit of the main engineering building of the Pennsylvania State College took place during the annual industrial conference, which opened on May 14. The building was erected and equipped at a cost of $350,000 as part of the four-year $4,250,000 building program whose completion will be celebrated this Fall on the occasion of the seventy-fifth anniversary of the founding of the college. Speakers at the dedication included Messrs. N. F. Dougherty, of the General Motors Corporation; L. K. Sillcox, vice-president of the New York Air Brake Company; F. J. Chesterman, vice-president of the Bell Telephone Company of Pennsylvania; R. L. Streeter, vice-president of the Pennsylvania Railroad, and Dean Sackett.

AT a general meeting of the members of the Royal Institution held on May 7, Sir Robert Robertson, treasurer and vice-president, in the chair, it was announced that the managers had received and accepted from the trustees of the Rockefeller Foundation an offer of a donation of £20,000 for endowment of research in the Davy Faraday Laboratory, on condition that the sum of £50,000 for the same purpose should be secured by the Royal Institution from other sources before June 30, 1933.

THE Rockefeller Foundation has given $150,000 to the University of the Philippines to construct a building to house the university's Graduate School of Hygiene and Public Health. A condition that the university provide a suitable site and an annual budget of $40,000 has been met. The University of the Philippines is owned and operated by the state. It has about 5,000 students, most of them Filipinos.

THE Permanent Science Fund held by the Boston Safe and Deposit Company as trustee has made through the Boston Academy of Arts and Sciences the following appropriations: To Professor Harlow Shapley, of Harvard University, $500 to be devoted to the employment of an experienced assistant in measuring periods and light curves of variable stars of the Cepheid class, and $1,000 for the employment of an expert assistant in a systematic study of eclipsing binaries by means of the Harvard plates; to Professor

C. T. Brues, of Bussey Institution, Harvard University, $600 for the purpose of photographic equipment and materials to aid in a study of the movement of insects; to Professor C. I. Reed, of the University of Illinois College of Medicine, $500 for use in a study of the influence of irradiated ergosterol on metabolism, and to Professor J. Leroy Conel, Boston University School of Medicine, $500 to be used for the collection of embryos of the hagfish, *Bdellostoma stouti*, necessary for the completion of researches on the development of the brain.

THE Geographic Society of Chicago has inaugurated a Research Series of lectures arranged by the research committee, of which Professor William H. Haas, of Northwestern University, is chairman. In announcing this series of lectures the society continues the policy which it adopted last year. The essentials of this policy are (1) that the lectures be given by men of recognized standing in scientific geography, (2) that the lectures represent field investigations of significant problems and (3) that the lectures be given for the first time before the society. The lectures are held in Fullerton Hall, Art Institute of Chicago. The titles for 1930 are as follows: March 19—Dr. Preston E. James, the University of Michigan, "Vicksburg: A Study in Urban Geography." April 23—Dr. Charles C. Colby, the University of Chicago, "Regional Integrity and Intra-regional Variations as Evidenced by Peace River Communities." May 19—Dr. Derwent S. Whittlesey, Harvard University, "The Lancaster Community: A Study of Land Occupance in Northern New England Sequent to the Epoch of Farm Abandonment."

Two new funds have been made available to the National Research Council for research. One of these, an appropriation of $22,500 from the Spelman Fund, is for the continuation of the work of the committee of the Division of Anthropology and Psychology on child development for the two fiscal years, 1930-31 and 1931-32, at the rate of $10,000 per year, and includes also $2,500 to cover the quarter from the close of the present fiscal year of the committee on March 31, to the beginning of the regular fiscal year of the council on July 1. The second fund is an appropriation of $18,800 from the Commonwealth Fund for the support of the work of the joint committee of the Divisions of Medical Sciences and of Biology and Agriculture on infectious abortion for a three-year program of study on this pernicious disease. This money will be applied toward the maintenance of a cooperative central laboratory at the Michigan State College of Agriculture and Applied Science for the culture and study of strains of the organism, *Brucella*, the cause of the disease.

MR. DANIEL C. JACKLING, of San Francisco, president of the Utah Copper Company, has made provision for the establishment at the Missouri School of Mines and Metallurgy at Rolla, of which he is a graduate, of the Jackling Foundation for education in the sciences and arts pertaining to the mineral industry, its purpose being to aid worthy students by means of generous loan funds and to provide scholarships and special educational features not ordinarily provided for at state schools. The fund, through contributions already made and to be made by Mr. Jackling, may eventually amount to $600,000. Of this amount $100,000 is to be used as a loan fund, and the income from $500,000 for scholarships and special educational purposes. About twenty years ago Mr. Jackling established the Jackling Loan Fund at the School of Mines, which has already given assistance to three hundred students.

ACCORDING to the London *Times* at a hearing before Bromley justices it was ruled that the British Association must pay taxes on Down House, Darwin's old home. Mr. O. J. R. Howarth, secretary of the association, who lives at Down House, said that in 1928 Sir Arthur Keith, then president of the association, made a deed for the preservation of Down House. Mr. George Buckston Browne then acquired the property at his own expense and had it transferred to the British Association, together with an endowment for its maintenance as a memorial to Darwin. He intended that the house and grounds should be used for the benefit of science. The witness went to live here in September, 1929. He was the servant of the association, and had a large number of duties to perform. Cross-examined by Mr. Done, the witness said he carried on his duties at Burlington House and at Down House. Before Down House was acquired all the work was done at Burlington House. The secretarial staff was kept at Burlington House The staff at Down House consisted of two custodians and a gardener. A very substantial correspondence was addressed to him at Down House. Mr. Lane submitted that Mr. Howarth resided on the premises exclusively to carry out the objects of the association. Mr. Done held that Mr. Howarth's main object in living at Down House was residential. The chairman, in giving the decision of the bench, said they were of opinion that the occupation of part of the premises by Mr. Howarth under the terms of the arrangement between him and the association was such that, although the association was exempt under the Scientific Societies Act, 1843, the premises could not be considered to be occupied exclusively for the transaction of the business of the association or for the carrying out of its objects.

THE British Secretary of State for the Colonies has asked the High Commissioner for the Malay States to appoint Mr. Theodore Hubback, lately honorary Game Warden in Pahang, to report on the whole question of the wild fauna of Malaya. It is contemplated that a high official of the Federated Malay States government should be associated with him as assessor. In general the object of the appointment is to make regulations for the preservation of wild life, including the administration of national parks, wild life refuges and game reserves, and to suggest methods for dealing with any damage to agriculture done by wild animals.

DISCUSSION

THE "GIBBS PHENOMENON"—A MISNOMER

A FOURIER series corresponding to a function, $f(x)$ of period 2π, and convergent over an interval on the X-axis over which $f(x)$ is continuous, under very general conditions converges uniformly over any closed subinterval. If, however, $f(x)$ has a discontinuity of the kind sometimes called a "finite jump" in an interval over which it is otherwise continuous, convergence is not uniform over any neighborhood of this point. The approximation curves, $y = s_n(x)$, have maxima and minima whose distances from the limit curve, $y = f(x)$, do not approach zero when n becomes infinite, although the abscissa of each such extreme value identified by counting from the discontinuity approaches the abscissa of the discontinuity. Briefly, this is what is known as the "Gibbs phenomenon." It seems to have been first noticed by Gibbs and was briefly described by him in a note in *Nature*[1] published in 1899. The name was applied by Bôcher in his widely read paper[2] on Fourier series. The approach by Gibbs and Bôcher and generally by subsequent writers was graphical, and the "phenomenon" should be thought of as a graphical one.

However, this "phenomenon" is in no way limited to Fourier series but is characteristic of the approximation curves of many non-uniformly convergent series. In two papers[3] now classical in the theory of uniform convergence Osgood treats with exhaustive care the behavior of "peaks" in the neighborhood of points of non-uniform convergence. He does not explicitly study Fourier series. But the behavior of approximation curves is a general problem and it is treated by Osgood in a general way. There is nothing essential to the so-called "Gibbs phenomenon" which he does not study and illustrate by examples. His approach is primarily graphical and his papers antedate the note of Gibbs by three years. His treatment is careful and thorough as against the somewhat casual character of Gibbs's note.

If the name of any individual is to be applied to the behavior of "peaks" in the neighborhood of points of non-uniform convergence it should be the name of Osgood. The term Gibbs phenomenon has been applied to such behavior in the study of series of Bessel's[4] functions. Even if the name is retained for Fourier series, I do not see that it is justified for other series. Its only justification is that Gibbs remarked for Fourier series a situation the essentials of which were already widely known for other series.

TOMLINSON FORT

LEHIGH UNIVERSITY,
JANUARY, 1930

THE PROBLEM OF SALINE DRINKING WATERS

IN the February 21, 1930, issue of SCIENCE, V. G. Heller and C. H. Larwood reported experiments on the deleterious effects of certain saline drinking waters. In the course of a ground-water survey of northwestern Minnesota a few years ago, the writer had opportunity to observe in the field similar effects from waters of moderate concentrations, mostly lower than those reported by Heller and Larwood. The worst waters appeared to be those rich in sulphates. The waters are commonly (though often incorrectly) referred to as "alkali" waters. The sulphates in some waters are accompanied by true alkali, *i.e.*, soda or potash, but lime and magnesia generally are more abundant. Some are associated with high chlorides and others are not.

These high sulphate waters in Minnesota are common in the till-plain just east of the glacial Lake Agassiz basin and in the lake-bed itself (now the Red River Valley). Thus nine representative samples taken from various depths and localities in Stevens County range in salinity from 664 to 2,800 p.p.m., and the average of the nine is 1,575 p.p.m. anhydrous salts. The minimum sulphate is 29 per cent., the maximum 58 per cent. and the average 49 per cent., or approximately 770 p.p.m. The averages of the other main constituents are: Ca 14 per cent., Mg 5 per cent., Na 11 per cent., K 2 per cent., CO_3 (including HCO_3, recalculated) 16 per cent., Cl 1 per cent. In four of the nine samples, Na is more abundant than Ca. The low amount of chloride is noteworthy.

In the Cretaceous waters which are tapped by drilling in the Red River Valley farther west, sulphates and chlorides (apparently connate) are both abundant. Thus water from a city well at Wheaton, Minnesota, shows Ca and Mg 1 per cent., Na 33 per cent., K 4 per cent., CO_3 4 per cent., SO_4 28 per cent. and Cl 30 per cent.; total salinity, 2,794 p.p.m. This is a typical soft salty water of the region. Similar waters occur in the basal sand of the Cretaceous rock system northward to the Canadian boundary, but with a salinity as high as 10,000 p.p.m. or more. Toward the east these waters are diluted and become sodium or calcium bicarbonate waters. The waters from the glacial drift above the Cretaceous beds are bicarbonate solutions of Ca or Na, but many show high sulphates also. Waters from wells ending in the clays of glacial Lake Agassiz are notoriously high in sulphates, so that they have a bitter taste and drastic purgative effect on the drinker. In one case a 12-inch bored well 45 feet deep furnishes water containing 2,104 p.p.m. SO_4 in a total salinity of 3,600 p.p.m. As an extreme, another 80-foot well furnishes water with 3,590 p.p.m. SO_4 in a total salinity of 5,756 p.p.m.

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[1] Josiah Willard Gibbs, *Nature*, 59: 606.

[2] Maxime Bôcher, *Annals of Mathematics*, 7: 129, 1906.

[3] William Fogg Osgood, "Non-uniform Convergence and the Integration of Series Term by Term," *Amer. Jour. of Math.*, 19 (1897), read August 31, 1896; "A Geometrical Method for the Treatment of Uniform Convergence and Certain Double Limits," *Bull. Amer. Math. Soc.*, 3: 59, November, 1896, read August 31, 1896.

[4] For example, C. N. Moore, *Bull. Amer. Math. Soc.*, 34: 414, 1928.

The drastic cathartic action and the weakening effect of these natural solutions of Epsom and Glaubers salts on man and on live stock are well known in the region. Some persons believe that disorders of kidneys and bladder also result, but that effect is not established. It seems true though that no matter how well they are fed, cattle and hogs can not be fattened for market while they drink such water. Indeed, the case is even worse. The cattle develop a run-down, ragged appearance and many eventually weaken and die prematurely. The principal difficulty in such cases seems to be that a degeneration of the bones sets in, so that most of the lime is abstracted from them. These bones are reduced to gristle that can be tied in knots and easily punctured with a knife. Calves are stunted in growth and many never mature at all. The cows develop strange appetites for bones, leather, wood, etc. The condition is alleviated but perhaps not cured by feeding bone-meal or ground limestone.

Altogether about one fourth of the State of Minnesota is affected in some degree by this problem. Furthermore, the observation of cattle from Dakota and Montana, where similar waters are known, suggests that the difficulty is really wide-spread but has not been properly diagnosed. With the present trend toward "diversified farming" involving cattle-raising and dairying, a considerable territory faces a critical problem. It seems probable that people using such waters are affected in the same way as cattle, but perhaps in different degree, so that questions of human physiology and diet also are involved.

It is to be hoped that the experimental work of Heller and Larwood will be continued, and that the effect on the equilibrium of body calcium may be studied in particular, because the problem has a large economic bearing.

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A SURVEY OF THE PHYTOPLANKTON AT ERIE, PENNSYLVANIA

In a recent number of Science[1] Mr. Paul R. Burkholder outlined briefly the scope of the biological survey of Lake Erie which was carried out during the summers of 1928 and 1929 through the cooperation of the U. S. Bureau of Fisheries, Buffalo Society of Natural Sciences, N. Y. State Conservation Department, Buffalo Health Department and the fish and game departments of Ohio, Ontario and Pennsylvania. Attention should be called, also, to similar investigations being carried on at Erie, Pennsylvania, by graduate assistants in the University of Pittsburgh appointed for that purpose. The present note refers only to the work carried on by the assistant in the botanical department of the university.

Early in the spring of 1929, Mr. Herbert Graham began quantitative and qualitative studies of the raw Lake Erie water taken in at the large city waterworks intake crib situated out in the lake about two miles from the shore of Presque Isle and about three miles out from the main shore at Erie. The water is taken into this main at a level of about six feet above the lake-bottom and twenty-four feet below the surface of the water. Generally, two samples of this water were studied each week, the organisms identified and their abundance estimated. In the late spring Mr. Graham left to become a member of the staff of the ill-fated *Carnegie*, being succeeded by Mr. Russell Y. Gottschall, who has continued the investigation.

The notable results of this study consist mainly in that there is now a continuous record of the phytoplankton organisms throughout the whole year, based on studies of about 250 samples and including about 65 organisms determined as to species and various others as to genera. It is believed that this study will thus supplement in a very important way the more general biological survey carried on only from May to September. The Erie samples are also much more productive, as a larger number of the organisms are caught by the lake-sand filter method used than by the tow-net and bottle method.

Being an expert bacteriologist, Mr. Gottschall has extended the studies to cover the bacterial flora of Erie Bay, as well as its general phytoplankton, and has carried on a number of oxygen determinations, particularly during the colder months.

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[1] Science, 71: 288, March 14, 1930.

O. E. JENNINGS

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THE VITALITY OF BURIED SEEDS

Two long-term seed tests have been started in the United States, and are still in progress. The first was started by Dr. W. J. Beal at the Michigan Agricultural College. In this test, one half of the kinds germinated after forty years. The other was begun by the Seed Laboratory, Bureau of Plant Industry, U. S. Department of Agriculture, in 1902 at Arlington Farm, Virginia. At the end of twenty years, fifty-one of the 107 kinds planted were viable. Other sets of seeds in both tests remain buried and will be taken up and germinated at intervals. These two tests have been particularly suggestive with respect to revegetation and crop rotation in relation to weed control.

It now seems desirable to put down a more comprehensive long-time series of tests to determine the effect of typical soil and climatic conditions on the length of time seeds will remain alive when embedded in the soil. Such a test is now being planned by the Seed Laboratory, Bureau of Plant Industry, U. S. Department of Agriculture. The success of the project will require the cooperation of many interested organizations and individuals. Suggestions as to characteristic areas with reference to both soil and climate will be welcomed as well as suggestions as to the kinds of seeds of particular interest in these typical localities. It is expected that the seeds used will be of the crop of 1931, and that they will be placed in the ground during the fall of that year.

E. BROWN

SPECIAL CORRESPONDENCE

RESEARCH AT THE MELLON INSTITUTE DURING 1929–30

SINCE Mellon Institute was established in Pittsburgh nineteen years ago, about thirty-five hundred companies have benefited directly, either as individuals or as members of industrial associations, by the work carried out under the institution's industrial fellowship system. Robert Kennedy Duncan, the originator of this procedure, envisioned as its goal ideal industry, which would "give to all broader opportunities for purposeful lives." The double function of the institute as a technical experiment station and as a training school for industrial scientists is manifested by the successful products and processes worked out under its auspices and by the regiment of earnest researchers who have here gained knowledge and experience that they are now applying in wider fields.

In his seventeenth annual report to the institute's board of trustees, just issued, Director Weidlein has summarized the progress during the fiscal year ended February 28, 1930. A quantitative measure of the activities is afforded by the funds contributed by the industries in this period for the support of research, which reached the sum of $929,109.02, showing an increase of 16 per cent. over the preceding year. At the close of the year, sixty-one problems were under investigation, twenty-one by multiple industrial fellowships and forty by individual industrial fellowships. Eight studies are being supported by industrial associations. Five additional fellowships will begin work during the spring. One hundred and forty-three industrial fellows and fellowship assistants are carrying on the experimental work. During the calendar year 1929, publications by members of the institute included seven bulletins, fifty research reports and fifty-nine other papers. Sixteen United States patents were issued to industrial fellows.

The institute expends its income not only in conducting research for the industries and in the extension of its library and experimental facilities, but also in sustaining its department of research in pure chemistry and in supporting certain investigations of general importance to public welfare, such as, for example, the comprehensive study of air pollution now in progress.[1] The fellowship on pure research, maintained since 1915, was perpetuated in 1927 as a separate department. In this way the institute is giving constantly increasing attention to the encouragement of research on fundamental chemical problems. This attitude is the result of altruistic motives and of the realization that such studies are necessary as a background and stimulus for industrial research. Since this department was established, it has published nineteen papers on various subjects in pure organic chemistry. Most recently its work has been on the acidic carbohydrates occurring in plants.

Of the sixty-one fellowships now active, twenty-nine, approximately half, have been in operation for five years or more. Fifteen have completed more than ten years of work. These facts bear witness to the growing realization by industrialists that long-time, fundamental research is profitable.

Information concerning the subject-matter and progress of many of the fellowships is not releasable. The following developments during the year are among those of which the institute is privileged to speak. The Portland cement fellowship has carried on a cooperative study of bricklaying in the course of which 350 experimental walls and two small experimental houses have been built; the project is being conducted along broad but thoroughly practical lines with the advisory help of a group of brick manufacturers, construction engineers, architects and brickmasons. A second new breakfast food has been developed by the food varieties fellowship, and the work on carbonated beverages has resulted in valuable contributions to the technology of extract manufacture in this industry. The studies on cooking utensils have shown that corrosion during cooking operations is insignificant in degree and does not contribute in any way to food poisoning or other diseases. The investigation of sleep has been one of the outstandingly productive projects of the institute. A new high-temperature insulating material has been worked out by the fellowship on heat insulation, and the contributions of the vitrified sewer-pipe fellowship have led to important economies in fuel consumption in this industry. The laundry and petroleum production fellowships have been partly transferred to the donors' organizations, certain of the fundamental problems remaining in the institute. Comprehensive studies on iodine are now in progress.[2] The process for the chrome-plating of aluminum worked out in the institute is now being applied commercially on a large scale. The organic synthesis fellowship has been remarkably successful in developing new, commercially valuable compounds for a wide variety of industrial uses. The plastic vinylite resin is one of the latest additions to this large list of products from hydrocarbon gases.

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[1] On the institute's air-pollution investigational program, see L. W. Bass, SCIENCE, 70: 186, August 23, 1929.

Ten fellowships—those on surgical supplies, felt hat manufacture, aluminum plating of chromium, licorice, beds, gum, industrial alcohol and stearic acid, and two fellowships on cast iron—completed their investigational programs during the fiscal year. Nine new fellowships became active: rosin oil, garment, hemp paper, steel treatment, can, nicotine, wood by-products, fatty acid uses and oxygen. The institution has been obliged, because of lack of space, to postpone the acceptance of several important problems.

The 143 men composing the industrial fellowship personnel at the end of the fiscal year hold degrees from seventy-eight universities and colleges.[3] Of the 109 men with the rank of senior industrial fellow or industrial fellow, 46 have the Ph.D. or Sc.D. degree, and 22 others have a master's or advanced engineering degree.

Since 1925 the institute has sponsored each year a series of radio talks on late progress in science and technology, broadcast from the University of Pittsburgh Studio of Station KDKA. In a similar manner the importance of science to the nation's welfare is kept before the public by means of public addresses and newspaper and magazine articles prepared by members of the institute.[4]

During the nineteen years since the establishment of Mellon Institute at Pittsburgh, the amount of money appropriated to it by companies and associations was $6,749,273. The total contributions to scientific literature comprise 15 books; 96 bulletins; 528 research reports; 849 other articles, and 407 United States patents.

LAWRENCE W. BASS,
Executive Assistant

MELLON INSTITUTE OF
INDUSTRIAL RESEARCH

QUOTATIONS

A NEW HEALTH INSTITUTE

BLANKETED by the debates over the tariff, the treaty and the Supreme Court, a bill has slipped through Congress, almost unnoticed, which will have a place in governmental history. It sets up a National Institute of Health. This has long been the dream of Senator Ransdell, of Louisiana. In realizing it he has had the support of the American Medical Association, the American Public Health Association and various scientific bodies. His bill has the endorsement of Secretary Mellon and will doubtless be signed by President Hoover, who has always taken a special interest in scientific research and in government agencies to further it.

Under the Ransdell bill the Hygienic Laboratory is made the nucleus of the new establishment, which will be devoted to the purpose of inquiring into the cause, prevention and cure of diseases. The Treasury Department is specifically authorized to accept gifts from private sources for the furtherance of these investigations, much as the Library of Congress was authorized some years ago to accept donations in its field. A system of fellowships in scientific research has been devised in order to secure the proper personnel and to encourage men and women of exceptional proficiency to devote their efforts to the war on disease. While a great deal has been accomplished by the universities, medical schools and endowed institutions, these efforts heretofore have often lacked coordination. The idea is to make the institute "a great cooperative scientific organization in which leading experts in every branch of science will be brought together and given an opportunity to work in unison for the purpose of discovering the natural laws governing human life."

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[2] On the institute's researches on iodine, see L. W. Bass, SCIENCE, 71: 37, January 10, 1930.

[3] On the institutional sources of industrial research men, see W. A. Hamor, SCIENCE, 51: 625, 1920; 64: 380, 1926.

[4] For a full account of the educational activities of Mellon Institute, see W. A. Hamor and L. W. Bass, *J. Chem. Education*, 7: 81, 1930.

The country's annual "human repair bill" runs to about $1,000,000,000. That takes no account of loss of time or loss of life from preventable disease. Congress has appropriated vast sums for research in crops and live stock, in mines and minerals, and in the problems and processes of industry, but it has done comparatively little to further the cause of human health. The workers in the Hygienic Laboratory have shown what could be done even with meager funds. With the far larger resources that the National Health Institute will ultimately command, it should be capable of doing great things.—*The New York Times.*

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN IMPROVED DESIGN FOR A SIMPLE LABORATORY PLANT-DRIER

Though heated air, with the aid of a variety of devices, is commonly utilized by botanists for drying their specimens rapidly while in the field, the older and much slower process of curing under pressure, by the changing of absorbent pads or blotters, is still very widely used in the college and high-school laboratories of the country. That teaching botanists have not more generally taken advantage, both for themselves and for their students, of the time-saving and trouble-eliminating method of heat-curing is undoubtedly due quite as much to the fact that no entirely satisfactory apparatus has been made available as to any prejudice against the method.

The writer, during the past nine years, has been constantly under the necessity of accomplishing quickly in his laboratory the curing of botanical specimens collected under field conditions that prohibit the use there of either blotters or heaters. To overcome this difficulty, various types of driers have been made and tested in the laboratory, where the specimens are sent as soon as possible after being collected, and finally a satisfactory drier has been obtained. It was built according to the plan shown in the accompanying drawing, as a permanent piece of laboratory equipment.

This drier, though developed independently, is similar in many ways to an apparatus described by Dr. H. S. Jackson in the "Report of the New York State Botanist for 1924,"[1] but it embodies several improvements and advantageous modifications not found in Dr. Jackson's drier.

This newly designed plant-drier consists essentially of a four-sided wooden box set on legs at a convenient height and provided with two electric lamps to furnish the needed heat. It is open at the top, but the bottom is closed by a galvanized iron pan which, while being perforated with a number of holes to admit cold air, retains and stores heated air beneath the pack of specimens.

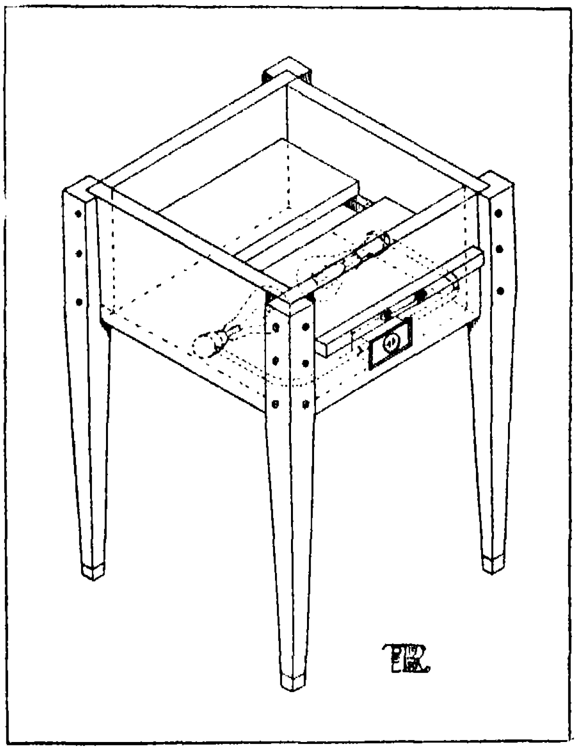

Fig. 1

A narrow ledge fastened around the inner walls of the box, halfway between top and bottom, serves as a support for the pack of specimens; and two sliding shelves, which rest on this ledge and are adjustable to the size of the pack, prevent the escape of heated air along its sides.

Except the legs, which are of oak, all wooden parts are made of yellow poplar, in order to reduce warping to a minimum. When the usual black laboratory stain is applied to the box, inside and out, and to the shelves, and when the legs are finished with orange shellac and clear varnish an appearance is obtained that is both pleasing and in harmony with other laboratory furniture.

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[1] New York State Museum Bul. 266, pp. 99–101, 1925.

The specimen pack is prepared for drying, as in other cases where heated air is utilized, by separating the specimens from each other with corrugated strawboard, the corrugations running, of course, the short way of the pack, so as to be vertical when the pack is set in the drier. After being strapped tightly between press-boards or lattices, the pack is set on edge in the drier, the sliding shelves adjusted to its sides and the electric current turned on. The rate of drying can be controlled by the size of lamp used.

In our hands, this drier has proved very satisfactory indeed. It is, first of all, a complete and independent unit. As it occupies but little space, it can be conveniently installed in a crowded laboratory. Requiring only to be connected with an electric current, it is always ready for use, and large or small sets of specimens can be handled in it with equal facility. A full pack of wet aquatic plants can be dried in from eight to ten hours by using two 100-watt lamps. There is, moreover, no danger of fire, and the specimens are not subjected to scorching or overheating.

L. R. TEHON

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SPECIAL ARTICLES

DIRECT TRANSMISSION OF HUMAN TRACHOMA TO THE MONKEY

IN previous notes we drew attention to the successful transmission of experimental trachoma from monkey to monkey by (*a*) simple caging together of infected and uninfected *Macacus rhesus*,[1] (*b*) by repeated swabbing of the normal conjunctivae with the secretions from the experimental lesions in *Macacus rhesus*[2] and (*c*) by the repeated instillation of cultures of *Bact. granulosis* into the conjunctival sac of normal rhesus with subsequent massage of the eyelid.[2] The last method is, of course, not an example of monkey to monkey transmission except in respect to the principle of eye to eye conveyance.

In this note we are reporting two instances of direct transmission of trachoma by means of secretions from human cases to normal *Macacus rhesus*, which showed, previously to the swabbings, smooth conjunctivae. For the materials and effective cooperation we are indebted to Dr. Martin Cohen, of New York.

The cases consisted of two white persons residing in New York. Case A had suffered from trachoma for ten years. The lesions were characteristic, consisting of granulations, extensive scar formation and pannus. Case B had suffered from the active disease for two years. The lesions consisted also of granulations, scars and pannus.

The secretions from each case were taken on cotton swabs and transferred directly, by gentle rubbing, to the smooth conjunctivae of each of three monkeys. Nine swabbings were made from man to monkey in Case A and seven in Case B.

Thirteen days after the last swabbing from Case A, one monkey showed granular lesions of experimental trachoma, and thirteen days after the last transfer from Case B the three respective monkeys presented typical granulomatous changes.

Conjunctival tissue was removed from Case A for curative purposes by Dr. Cohen and employed for direct subconjunctival injections in three further normal *Macacus rhesus* presenting smooth conjunctivae. Within four to ten days, all three developed granular lesions of experimental trachoma. The excised tissue was also employed for bacteriological study. Cultures of *Bact. granulosis* were isolated, and these when injected subconjunctivally into three normal monkeys induced in all experimental trachomatous changes in nine to eleven days.

Finally, granulomatous tissue removed from the monkey infected by swabbing from Case A yielded cultures of *Bact. granulosis*.

The direct transmission of trachoma to monkeys has already been effected by several investigators,[3] but the present experiments are the first in which both transmission and the isolation of *Bact. granulosis* have been successful with the same trachomatous material.

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ASSOCIATION AND CONSTITUTION

THE study of the properties of compounds has unfortunately not yet made it possible to predict the properties of associated compounds with any degree of success. It now appears that the association as measured by the fluidity method varies regularly in a given homologous series, so that the association itself may be calculated, thus permitting the calculation of other properties dependent upon the association. It is found that groups causing association, such as carboxyl, hydroxyl, sulphydrate, *etc.*, are most active at the end of a paraffin chain and are less active as the paraffin chain is shortened or as the active groups are moved toward the center of the paraffin chain. These effects may be incorporated in a formula.[1]

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[1] J. R. Tyler, SCIENCE, 70: 612, 1929.

[2] P. K. Olitsky and J. R. Tyler, SCIENCE, 71: 263, 1930.

[3] For literature see: H. Noguchi, *Jour. Exper. Med.*, Supplement No. 2, 1928, xlviii; and V. Morax and P. J. Petit, "Le Trachome," Paris, 1929.

THE OBSERVED AND CALCULATED ABSOLUTE TEMPERATURES REQUIRED TO GIVE A FLUIDITY OF 100 RHES TO VARIOUS ACIDS, WITH THE PREDICTED ASSOCIATIONS

Substance	Predicted association at $\varphi = 100$ Rhes	Predicted absolute temperature to produce $\varphi = 100$ Rhes	Observed absolute temperature to produce $\varphi = 100$ Rhes	Percentage difference
Formic acid	2.225	325.5	324.7*	0.2
Acetic acid	1.841	304.9	305.7*	0.3
Propionic acid	1.816	298.8	300.0*	0.4
Butyric acid	1.572	321.0	320.2*	0.2
Valeric acid	1.527	341.3	342.0*	0.2
Caproic acid	1.482	359.8	361.3*	0.4
Heptylic acid	1.438	376.9	377.5	0.2
Caprilic acid	1.393	392.0	381.7*	2.7
Lauric acid	1.215	435.7	435.7	0.0

* Fluidity not measured by the authors.

THE OBSERVED AND CALCULATED ABSOLUTE TEMPERATURES REQUIRED TO GIVE A FLUIDITY OF 100 RHES TO VARIOUS ALCOHOLS TOGETHER WITH THE PREDICTED ASSOCIATIONS

Substance	Predicted association at $\varphi = 100$ Rhes	Predicted absolute temperature to produce $\varphi = 100$ Rhes	Observed absolute temperature to produce $\varphi = 100$ Rhes	Percentage difference
Methyl alcohol	2.097	272.0	263.2*	3.2
Ethyl alcohol	2.001	298.1	302.9*	1.6
Propyl alcohol	1.906	320.8	329.2*	2.6
Isopropyl alcohol	1.839	309.5	324.3*	4.8
Butyl alcohol	1.811	339.7	339.7*	0.0
Isobutyl alcohol	1.778	333.6	342.2*	2.6
Trimethyl carbinol	1.711	321.0	334.3*	4.1
Amyl alcohol	1.649	341.2	349.2*	2.3
Amyl (inactive) alcohol	1.682	348.0	349.2*	0.3
Dimethyl-ethyl carbinol	1.582	327.3	336.0*	2.7
Allyl alcohol	1.906	320.8	311.2*	2.7
n-Heptyl alcohol	1.525	374.4	362.3	3.2
n-Octyl alcohol	1.430	378.7	376.7	0.5

* Fluidity not measured by the authors.

The following tables will show the association as calculated by formula for certain compounds and also the temperatures required to give these compounds a fluidity of 100 rhes, the fluidity of water at 20° C. In the case of the mercaptans, the fluidity has, for convenience, been taken as 200 rhes.

THE OBSERVED AND PREDICTED ABSOLUTE TEMPERATURES REQUIRED TO GIVE A FLUIDITY OF 200 RHES TO VARIOUS MERCAPTANS TOGETHER WITH THE PREDICTED ASSOCIATIONS

Substance	Predicted association at $\varphi = 200$ Rhes	Predicted absolute temperature to produce $\varphi = 200$ Rhes	Observed absolute temperature to produce $\varphi = 200$ Rhes	Percentage difference
n-Ethyl mercaptan	1.118	250.0	247.5	1.0
n-Propyl mercaptan	1.107	272.0	273.5	0.6
n-Butyl mercaptan	1.095	293.2	293.1	0.0
n-Pentyl mercaptan	1.084	314.3	315.7	0.4
n-Hexyl mercaptan	1.072	334.5	335.8	0.3
n-Heptyl mercaptan	1.061	354.5	355.8	0.4
n-Octyl mercaptan	1.049	373.7	373.7	0.0
n-Nonyl mercaptan	1.038	392.7	389.7	0.8
Propane thiol - 2	1.082	265.8	269.0	1.2
Pentane thiol - 2	1.055	305.8	301.1	1.5
Hexane thiol - 2	1.041	324.8	321.9	0.9
Heptane thiol - 2	1.027	343.1	342.3	0.2
Octane thiol - 2	1.013	360.8	360.5	0.8
Nonane thiol - 2	1.000	378.3	378.3	0.0

If one excludes caprilic acid, the average deviation between the observed and calculated values for the acids is only 0.2 per cent., which is less than one tenth of the deviation shown by caprilic acid, so that we propose to prepare further samples of this substance in order to learn whether this difference is real or not. The average deviation with the thirteen alcohols is somewhat higher, averaging 2.3 per cent. If we include twenty-two different isomeric octyl alcohols, the deviation is 1.2 per cent. The average deviation for fourteen mercaptans is 0.6 per cent. Therefore the average deviation for fifty-seven calculated substances is 0.9 per cent.

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[1] See Eugene C. Bingham and Logan B. Darrall, *J. of Rheology*, 1: 174, 1930.

THE NATIONAL ACADEMY OF SCIENCES. III

Bending of curved tubes: **William Hovgaard.** This paper is an abstract of reports on a series of tests with curved tubes, such as are used as expansion bends in steam piping. The theoretical investigation, the tests and their analysis were carried out by the author during the years 1925 to 1929. The study began with the development of formulas for determining the deflections and stresses in such pipes when they are subject to bending. Suppose, for instance, that a bending couple, tending to increase the curvature, is applied to a pipe bend. The stress forces will then cause a small deformation of the transverse circular section which takes the form of an oval with its minor axis in the plane of bending. Hereby the material farthest from the neutral axis is largely relieved of longitudinal stresses, and the maximum values of these stresses, instead of occurring at the top and bottom of the section, as in the bending of a solid bar, occur at points much nearer to the neutral axis. The result is that equilibrium between the external bending moments and the internal stress couples will not be established until the bend has taken an angular deflection much greater than in the absence of sectional deformation. It follows that also the linear displacement of the ends of the pipe is much greater, a point which is of great importance to the engineer in the bends used in steam pipes to provide for expansion due to a rise in temperature. In all, nine full-scale pipe bends were tested in the laboratories of the Massachusetts Institute of Technology, varying in diameter from 4½ inches to 14 inches, and with a radius of curvature from one and one half to six times the diameter. The thickness of the pipe wall covered a wide range, the pipes being designed for steam pressures varying from about 100 to 600 pounds per square inch. The analysis of the tests led to the following general conclusions: (1) The calculated values of the displacement of the ends of a bend relative to each other, as also of the sectional deformations, showed an excellent correspondence with the observed values. The calculated stresses, longitudinal as well as transverse, corresponded well with the stresses obtained by measurements so long as the material was within the elastic limit. (2) The elastic yielding capacity of the pipe bends seemed to be dominated by the magnitude of the longitudinal stresses. It was found that so long as these stresses did not exceed 20,000 pounds per square inch, there was no appreciable permanent set in a bend, although probably local overstrain existed at certain points. On the basis of these results it was recommended to design pipe bends for a calculated longitudinal stress of 16,000 pounds per square inch. A special study was made of the occurrence of plastic flow in the material, evidenced chiefly by the appearance of Lüders lines on the surface of the pipes, and indicated also by the measurements of the strain meters. The principal formulas used in the analysis are given in an appendix.

The effect of the annihilation of matter on the wave-length of light from the nebulae: **Richard C. Tolman.** The purpose of this paper is to examine the cause of the red-shift in the light from the extra-galactic nebulae, which has been found by Hubble and Humason to increase approximately linearly with the distance of the nebulae, and if interpreted as an ordinary Doppler effect would correspond to enormous velocities of recession for the more distant objects of this class. The method of attack is to investigate, on the basis of the principles of general relativity, what form of line element for the universe as a whole would correspond to the continuous transformation of matter into radiation which appears to be going on throughout the universe and then determine if this form of line element would have any effect on the wave-length of light from distant objects. Attention is first called to the fact that neither of the rival static line elements for the universe proposed by Einstein and by de Sitter gives a satisfactory explanation of the red-shift, and that previous work of the author has shown that these are the only *static* line elements which would agree with approximately uniform conditions throughout the universe. These static line elements, however, correspond in the Einstein case to a universe permanently filled with a constant distribution of matter and in the de Sitter case to a universe which is permanently empty. Hence if we accept the contemporary opinion of the astro-physicists that the universe is actually filled with a distribution of matter, which is continuously changing over into radiation, we must expect that the actual line element for the universe will be a non-static one corresponding to the non-static condition of the universe. By applying the requirements that conditions throughout the universe shall on the average be substantially uniform, and that particles (nebulae) which are at rest in the coordinates chosen shall remain so, as is necessary for the preservation of a stable distribution, the author is then able to obtain for the line element of the universe the expression

$$ds^2 = -\frac{e^{g(t)}}{\left(1+\frac{r^2}{4R^2}\right)^2}\left(dx^2+dy^2+dz^2\right)+dt^2 \qquad (1)$$

where R is a constant and g is a function of t which gives the dependence of the line element on the time. With the help of this form of line element, it is then possible to obtain an expression for the density of matter in the universe and to show that g must be changing with the time if a general transformation of matter into radiation is really taking place. Furthermore, if we apply the additional requirement that particles (nebulae) which are not exactly stationary in the coordinates chosen tend to become so, it can be shown that g must be increasing with the time, and this leads to a red-shift in the light from distant objects. Finally, assuming in the neighborhood of $t=0$ a simple linear dependence on time,

$$g = a + 2kt \qquad (2)$$

it is found that k is a quantity which is related on the one hand to the average rate at which matter is changing over into radiation and on the other hand to the known shift in wave-length with distance. By comparison with observational data it is then shown that the value of k necessary to account for the known red-shift falls close to the range of values which would correspond to the rates of transformation of matter into radiation for actual stars of different types, although considerably higher than that for an average star. In conclusion, it is pointed out that further information as to the exact dependence of the red-shift on distance and knowledge as to the concentration of dust in the universe and its rate of annihilation are very desirable. It is also emphasized that the simplification of the model used for the calculation and the assumptions, such as that of a linear dependence on time, make it necessary to regard the treatment given as not better than a first approximation to the correct theory.

The energy requirements of intense mental effort: FRANCIS G. BENEDICT and CORNELIA GOLAY BENEDICT. The popular tradition that fish is a brain food has given way to the idea that mental effort demands calories. The feeling of complete mental and physical exhaustion as an aftermath of intense, sustained mental effort has led to interest in the real dynamic effect of so-called "mental work." By measuring the changes in the heart rate, the respiration rate, the character of the respiration, the carbonic acid exhalation and especially the consumption of oxygen, definite evidence can be secured of the immediate results of intense mental effort. Studies made in earlier years on the influence of mental work upon heat production have shown either that the mental effort had no effect or a very pronounced effect. Further experiments have been made during the winter of 1930 at the Nutrition Laboratory of the Carnegie Institution of Washington, at Boston, in which the subjects (five men and one woman) were measured under three different conditions: first, during complete muscular and digestive repose and as nearly as possible in a state of mental vacuity; second, during "attention" or response to an electric signal, but with no active cerebral processes of a complex nature; third, during intense, sustained mental activity, as in the elaboration of mental arithmetic problems for an hour, at the end of which time each subject admitted that he was exhausted, at least mentally. The first series of observations with each subject represented the measurement of the now well-known "basal metabolism," a measurement made daily in the hospital, especially in suspected thyroid cases, and likewise used as evidence of the level of vital activity of normal persons. The problems, such as multiplying mentally 73 by 47, were given orally, and at the completion of each problem the subject touched a telegraph key. Problem followed problem as rapidly as solved, and with one subject a complexity represented by numbers such as 873 by 67 was reached successfully. The general picture of the effect of mental effort was the same with all subjects, a distinct increase in heart rate, a pronounced alteration in the general character of the respiration, a small increase in the carbonic acid exhalation and a slightly smaller increase in the oxygen consumption. In the periods of repose following the mental work all these factors immediately resumed their former level and nature. During the mental effort, lasting in some cases more than an hour, the different factors measured showed no increase from period to period during the four consecutive fifteen-minute periods. The response to mental effort is therefore immediate and not cumulative, at least when the mental effort is uniform in nature. From the slight increase in the carbonic acid exhalation and the oxygen consumption it is possible to calculate the extra heat produced during such mental effort, that is, the increase above the heat production during complete muscular, digestive and mental repose. From the standpoint of dynamics it is perhaps surprising that the extra caloric demands of mental effort are so small. The professor absorbed in intense mental effort for one hour has an extra demand for food or for calories during the entire hour not greater than the extra needs of the maid who dusts off his desk for five minutes. The cloistered scholar at his books may be surprised to learn that the extra calories needed for one hour of intense mental effort would be completely met by the eating of one oyster cracker or one half of a salted peanut.

The suppression of fluorescence in concentrated solutions: ERNEST MERRITT. In dilute solutions the "specific fluorescence" of a substance, *i.e.*, the fluorescent emission per molecule, has been found to be constant throughout a considerable range. But as the concentration is increased a point is finally reached at which the specific fluorescence suddenly begins to diminish exponentially with increasing concentration. Apparently when the molecules of the active substance are sufficiently close together some action occurs which inhibits the process of emission. It has been suggested that we have to do with collisions of the second kind or with some inductive action between the molecules which disturbs the conditions for radiation. Assuming that some action of this kind occurs when the distance between molecules is less than some specified distance, and assuming further that the active molecules are distributed at random, a law of variation of fluorescence with concentration has been derived for liquids by Perrin and for solids by Merritt. But this law indicates an exponential variation for *all* values of the concentration. In some cases the experimental results reported by Wawilow differ by as much as 50 per cent. from those computed by Perrin's formula. Abandoning the idea of random distribution the author assumes that the potential energy of the molecule of active material when at a distance from other similar molecules is less than its energy when near another active molecule. This makes it necessary to introduce the Boltzmann distribution law in computing the probable distribution and leads to a new expression for the specific fluorescence, F, namely:

$$F = \frac{F_0}{1 + (e^{\mu n} - 1)e^{Q/kT}}.$$

n = concentration; Q = energy (negative) required in bringing two active molecules together from a great distance; μ = a constant determined by the maximum distance apart at which one active molecule prevents radiation by the other. This expression represents the experimental results better than that derived on the assumption of random distribution. For large values of n the expression takes the form

$$F = F_0 e^{-\mu(n-n_0)},$$

which was given by Wawilow as best representing his results. The corresponding expression for the observed fluorescence in the case of a solid is also derived and is found to agree with the experimental results. The complicating effects of dissociation and the possible causes of the inhibiting action are discussed.

X-ray diffraction determinations of electron distributions in atoms: ARTHUR H. COMPTON. Work by Darwin, the author, the Braggs, Duane and others has made it possible to estimate from measurements of the intensity of X-ray diffraction by crystals the distribution of the electrons in the atoms of which the crystals are composed. Similar analysis now shows that the density of distribution of the electrons as a function of the distance from the center of an atom may be expressed as a Fourier integral, which can be evaluated from the observed intensities of the X-rays diffracted by amorphous substances. The theory, which is based on classical electrodynamics, is identical with the results of the quantum mechanics, except for a small correction which is to be applied when dealing with the diffraction of short waves at large angles. A comparison of the results obtained from the diffraction by gases with those calculated from the diffraction by crystals shows a close agreement in the general form of the electron distribution curves. The data from the gases show, however, a stronger concentration of the electrons near the center of the atom, a result which is doubtless due to the thermal agitation of the atoms in the crystal lattice, which gives to these atoms an apparent diffuseness. In fact, we are thus afforded an interference method of determining the amplitude of the atomic motions in a crystal lattice. The results are in qualitative accord with those to be expected from the usual kinetic theory.

Absorption spectra and the problem of the pyrones: R. C. GIBBS, J. R. JOHNSON and E. C. HUGHES (introduced by Ernest Merritt). Organic compounds that contain a pyrone ring exhibit certain unusual properties. Strictly chemical evidence as well as that of absorption spectra has led to conflicting suggestions regarding the structural formulas for the pyrones and their acid salts. Arguments have been advanced for the free substance chiefly in favor of either the ketonic structure with a quinoid-like nucleus or an inner salt formula, the nucleus of which is benzenoid. In forming an acid salt, the acid radical has been considered to be attached to either of the two oxygen atoms or to the carbon atom involved in the ketonic linkage thus producing either an oxonium or a carbonium salt. In seeking to secure crucial data that might serve to clarify the problem, the absorption spectra of gamma-pyrone, dimethyl pyrone, benzopyrone and xanthone in absolute alcohol and alcoholic HCl were carefully examined. Sulphuric acid solutions of two of these compounds were also examined. Whenever dissociation might conceivably occur and thus possibly modify the results, ether or dimethyl sulphate solutions were also measured. The absorption for the neutral solutions of gamma-pyrone and dimethyl pyrone is characteristic of that found for compounds known to have a ketonic linkage which, in these cases, involves a quinoid-like nucleus. Although the absorption in the case of neutral benzopyrone and xanthone is more complex due to the presence of benzene rings, the ketonic type of absorption also appears to be present in these compounds. The absorption curve for the acid solution of each of these four compounds resembles that for the corresponding neutral solution. It is therefore concluded that in forming an acid salt of these pyrones, the ketonic linkage is not broken and that an oxonium salt is produced through addition to the ketonic oxygen atom. The formation of a carbonium salt would have necessitated a rupturing of the ketonic linkage, thus producing a marked change in the nature of the absorption spectra. Furthermore the resemblance between the absorption of the free pyrones and that of their acid salts gives fairly conclusive evidence that these salts do not have an oxonium benzenoid structure, for such a structure would have yielded widely modified absorption spectra. Additional confirmation of these conclusions is obtained by comparing the absorption of 4-methoxy lutidine, a compound in which only the benzenoid structure is possible, with that of its ketonic isomer, N-methyl lutidone. The absorption spectrum of lutidone bears a close resemblance to that of pyrone, but that of lutidine is radically different, being similar in character to those for benzene and toluene.

BOOKS RECEIVED

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THE SYMMETRY OF TIME IN PHYSICS*

By Professor GILBERT N. LEWIS
UNIVERSITY OF CALIFORNIA

A FEW years ago I presented[1] the outline of a theory of light which required a radical change in our ideas of temporal causality. Instead of assuming the time-honored unidirectional causality, in which cause inevitably precedes effect, it proved necessary to assume that the present phenomena of a system are determined no more by the past states of the system than by its future states. Several recent developments in physics make this assumption seem less startling now than then; indeed I am fully convinced that there is no other way in which we can account for the known phenomena of light. Moreover, new discoveries in wave mechanics indicate that any conclusions concerning the emission of light must be extended to the emission of every kind of material particle.

By such considerations I was led, in "The Anatomy of Science," to examine with some care the meaning of time, as the word is used in physical science. It often happens that a common concept of daily life may profitably be simplified or refined when it is to be employed in a single branch of science. In studying the vastly complex phenomena of nature, as they come to us through our sense impressions, we could make little headway did we not segregate and idealize certain groups of like phenomena for the purpose of special study. Such segregations define the several branches of science, of which one of the most highly specialized and idealized is physics. Only a few types of phenomena are included within its bounds, and in its study we consciously abstain from employing many of our commonest ideas, such as purpose, goodness, beauty. In the physical sciences a statue of Praxiteles is a certain mass of crystalline calcium carbonate; the shape may or may not be mentioned. It was the scientific arrogance of a previous age that called a law of physics a law of nature. To speak so is to forget the bounds that we have ourselves established.

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* Address given on the occasion of the presentation of the gold medal of the Society of Arts and Sciences, New York, April 17, 1930.

[1] Nature, 117: 236, 1926.

It is therefore evident that such notions as those of time and space may be given a simpler significance when we are dealing with a single science than when we are concerned with the complexities of natural occurrences in general. Our common idea of time is notably unidirectional, but this is largely due to the phenomena of consciousness and memory. Was Newton right in deliberately introducing into physics this common idea of the *flow* of time? Surely in one great branch of physics which we owe to his genius, the mechanics of conservative systems, it has long been recognized that there is need for nothing more than the simple idea of symmetrical time, which makes no distinction between past and future.

These two ideas of time, the unidirectional and the symmetrical, I have for brevity called "one-way" and "two-way" time. In going from the very simple science of mechanics to the very complex science of psychology, we must change from two-way to one-way time. It is important to inquire where this transition comes, and whether two-way time suffices for some parts of physics while one-way time is needed for the remainder.

The thesis that I announced earlier, and now wish to elaborate, is that throughout the sciences of physics and chemistry, symmetrical or two-way time everywhere suffices. As a philosophic speculation this view has received some attention, but I shall be much disappointed if it can not also be accepted as the statement of a law of physics, of exceptional scope and power, directly applicable to the solution of many classical and modern problems of physics.

Let us therefore review the several great branches of physics in the light of this thesis of symmetrical time. These branches are mechanics, thermodynamics, theory of radiation and electromagnetics. We shall see that nearly everywhere the physicist has purged from his science the use of one-way time, as though aware that this idea introduces an anthropomorphic element, alien to the ideals of physics. Nevertheless, in several important cases unidirectional time and unidirectional causality have been invoked, but always, as we shall proceed to show, in support of some false doctrine.

MECHANICS

Mechanics includes the still more limited science of kinematics. For a century or more there have been attempts,[2] culminating in the brilliant work of Minkowski, to make kinematics a branch of geometry. It was the hope, now fulfilled, that time could be combined with space into a four-dimensional manifold, of which the geometry should reproduce the science of kinematics.

To lighten the discussion, let us imagine one of these precursors of Minkowski, whom we may call Dr. X. In one of his note books we might read, "If this geometrical view of kinematics is correct there must be no distinction of past and future. It would be absurd in Euclidean geometry to prove a theorem by means of a diagram, and then to claim that the theorem becomes invalid if the diagram is turned upside down. Likewise there is no up or down in the four-dimensional geometry of kinematics."

It was also the belief of Dr. X that the rest of mechanics could in turn be identified with a still more comprehensive geometry, and it seemed to him that this view received some corroboration in the fact that the mechanics of conservative systems requires no dissymmetry of time. All the equations of mechanics are equally valid when t is replaced by $-t$. The chance of error is the same in calculating an eclipse of a thousand years ago or of a thousand years hence.

Becoming even bolder, this eager speculator hoped that not only mechanics but all physics might eventually be reduced to a geometry. He wrote, "If this belief be correct, Newton's idea of a flow of time has no place in physics. Until I see strong evidence to the contrary, I shall maintain this to be a basic law of physics, that all rules which are obtained from a study of physical processes hold with equal validity if these processes are reversed in time. Every equation and every explanation used in physics must be compatible with the symmetry of time. Thus we can no longer regard effect as subsequent to cause. If we think of the present as pushed into existence by the past, we must in precisely the same sense think of it as pulled into existence by the future."

THERMODYNAMICS

The second law of thermodynamics was a source of uneasiness to Dr. X. Recognizing the importance of its consequences, he still objected to the statement of Clausius, namely, that in any system left to itself the entropy increases steadily toward a maximum. This statement is in direct defiance to the law of the symmetry of time. Therefore to Dr. X it was a great satisfaction to read in a paper of Willard Gibbs that "the impossibility of an uncompensated decrease of entropy seems to be reduced to an improbability"; and later to follow the development of this thesis by Boltzmann until near the end of the famous lectures on "Gastheorie" he found Boltzmann saying, "Hence, for the universe, both directions of time are indistinguishable, as in space there is no up or down."

Boltzmann's qualifications of this statement seemed unnecessary to Dr. X, who now definitely included thermodynamics among those branches of physics which require symmetrical time only. In his note book we read, "The statistical interpretation of thermodynamics offered by Gibbs and Boltzmann affords for the first time an understanding of entropy. The process irreversible in time does not exist. This corollary of the law of symmetry in time itself leads to further important consequences. Thence we may prove to those who are still skeptical the atomic structure of matter, as follows: if we imagine two continuous media to diffuse into one another, such a diffusion would in principle be a phenomenon which by no physical means could be reversed, but if two streams composed of discrete particles should diffuse, then, although it might be a matter of great difficulty to recapture the particles and restore each to its own kind, yet in principle the process is reversible and indeed, according to Boltzmann, the separation will occur spontaneously if the system be left to itself for a sufficiently long period."

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[2] *E.g.*, Fechner (Kleine Schriften), ''Der Raum hat vier Dimensionen.''

Dr. X adds a remark of much subtlety. "While we recognize the particulate nature of matter, we allow each particle to have a position and a velocity chosen from a whole continuum of possible values. Thus while we claim that an isolated system repeatedly returns nearly to its initial condition, we can not say that it returns exactly to that condition. If we start with a number of molecules all moving in precisely the same direction, we can not claim that after some disturbance they ever again move quite parallel to one another. This implies a sort of irreversibility, and while I am not sure that it is a contradiction to symmetrical time, I confess that I should be better satisfied if we could claim the exact recurrence of an initial state."

It is a pity that Dr. X did not live to see the universal acceptance of quantum theory, which assigns to an isolated system not an infinite continuum of states, but a finite number of discrete states. Thus every particular state exactly recurs within finite time. This modern picture is far simpler than that of Boltzmann, especially as we are going to see that each particular state occurs as often as every other. Hence molecular statistics furnishes quite elementary problems in the theory of probability, like the tossing of coins or the shuffling of cards.

In the main, however, the problems of thermodynamics to-day are not far different from those discussed by Boltzmann and Dr. X. In the note book of the latter we read, "The earth is constantly receiving energy from the sun, and in consequence water is continuously flowing over Niagara Falls, but these descriptive statements can not be called laws of physics. When we turn to the processes studied in the laboratory we find that when a hot and cold body are brought together, it is almost certain that the two temperatures will become equalized until no discernible difference remains. If we mix two mutually soluble liquids, we may expect the concentration to become nearly uniform. I have learned that it is possible to perform an operation upon the brains of mice so that they respond to no external stimuli, but can still run aimlessly about. If a large number of these mice are placed in one end of a box, that end is now heavier than the other; but this distinction rapidly disappears as the mice, in their random movements, cover with greater uniformity the bottom of the box, so that we may no longer discern any tendency of the box in one direction or the other. I claim that in all these cases there is no phenomenon irreversible in time, and indeed nothing more formidable occurs than in the proverbial case of a needle dropped into a haystack."

Before analyzing further these problems, we may consider a very interesting discussion of one-way time by Professor Eddington, in "The Nature of the Physical World." He arrives at a compromise, first by stating that one-way time does not occur in physics outside of thermodynamics, and then by reducing the principle of the increase of entropy from a "primary" to a "secondary" law, which does not prevent him, however, from deducing therefrom a "running down of the universe." To this compromise I can not agree. The first statement will be answered by the cases which will be discussed in the following sections, and the second can not be regarded as consistent with the new conception of thermodynamics.

We must be cautious about extending to the whole cosmos the rules which we have obtained from limited experiments in our small laboratories. The chance of obtaining valid results from such an extrapolation is very small, but it can be made in a purely formal way. If the universe is finite, as is now frequently supposed, then the formal application of our existing ideas of thermodynamics and statistics leads directly to the following statement: The precise present state of the universe has occurred in the past and will recur in the future, and in each case within finite time. Whether the universe actually is running down is, of course, another matter. All we can say is that such an assumption obtains no support from thermodynamics.

Let us, however, turn from the behavior of the universe, about which we know almost nothing, to the phenomena of the laboratory, about which we know a little more. Even in this limited domain it is going to be difficult enough to persuade ourselves that such a phenomenon as an explosion is wholly compatible with the thesis of symmetrical time. If a statement runs counter to a fixed habit of thought which has become nearly instinctive, it may be accepted by many, but believed by few. The use of one-way time has become second nature to us, and to oust from the mind all its implications, even when we set ourselves to do so, is no easy task. Nevertheless, perhaps we can make this task easier if we dig up by the roots and examine with all care this thing that we call an irreversible process.

We must begin by guarding against two human frailties—the feeling that there is some real distinction between familiar and unfamiliar things, and the fear of large numbers. Let us illustrate by means of a pack of cards, and at first a very small pack, say the ace, two, three and four of spades. There are twenty-four possible distributions, such as 1, 2, 3, 4; 4, 2, 1, 3; 4, 3, 2, 1, and so on. Of these the first and third are a little more easily described and remembered than the other twenty-two, which for this reason we call nondescript, but this is only a question of familiarity. A whist player would think of the arrangement, 1, 4, 3, 2, and there is no one of the twenty-four arrangements which might not be particularly significant in some other card game.

If our attention has been drawn to one particular distribution, we remark upon it when it results from random shuffling; but on the average each distribution, whether or not it has been favored by our attention, will turn up once in twenty-four times. If we now take a pack of fifty-two cards, the familiar, or easily described, distributions are relatively rare compared with all the nondescript arrangements, and if random shuffling should give the exact distribution of the pack as it comes from the manufacturer it would seem almost a miracle; yet we can say with the same certainty as before that any one particular distribution will, on the average, occur once in 52! times. The rules of arithmetic are the same for large numbers as for small.

There is no such thing as a well-shuffled pack, except with reference to certain familiar sequences. If the distribution does not closely resemble some familiar sequence, we might call it well shuffled. There is, however, another sense in which the idea of shuffling is of fundamental significance. If we examine a particular distribution and remember the sequence of the cards, afterwards the pack is said to be well shuffled when our remembrance of the previous distribution no longer aids us in guessing what a new distribution will be. This distinction between a known distribution and an entirely unknown one will prove to be fundamental in our study of the corresponding problems of thermodynamics.

Turning now to the irreversible thermodynamic process, we shall choose an illustration which is not quite so complicated as an explosion, but involves all essentials. A chemist has spent days in preparing a flask of nearly pure alcohol. This he places in a water bath, and then by accident the flask overturns and the alcohol diffuses through the water. His disappointment is in no way allayed by the fact that none of his material is really lost, nor by the belief that ultimately the molecules of alcohol will accidentally come together to give once more a nearly pure sample. That the chemist would be obliged to wait an unconscionable time for this chance restoration must be given no weight. If it occurred every ten minutes, the principle would be the same. It would still be necessary for him to devise rapid analytical methods to ascertain just when the fortunate event occurred. There is no question but that the accident has involved an element of *loss* which typifies the irreversible process (which is also spoken of as a process of dissipation, or degradation), but we shall see that this loss in no way implies a dissymmetry of time, nor indeed that it has any temporal implications whatever.

Without losing any of the characteristics of the reversible process, we may next examine one of the simplest of systems. Suppose that we have a cylinder closed at each end, and with a middle wall provided with a shutter. In this cylinder are one molecule each of three different gases, A, B and C, and the cylinder is in a thermostat at temperature T. In dealing with the individual molecules we are perhaps arrogating to ourselves the privileges of Maxwell's demon; but in recent years, if I may say so without offense, physicists have become demons.

Regarding each molecule, we shall ask only whether it is in the right or the left half of the cylinder. Obviously eight distributions are possible, such as A and B on the left and C on the right; or B on the left and A and C on the right. According to our ordinary assumptions, each of these distributions is equally probable, or, in other words, the system averages to be in each distribution one eighth of the time. Moreover, each of the eight distributions can be easily described and remembered, so that we are not troubled by a large number of nondescript states. Each distribution occurs over and over, but in no particular order, and in these occurrences there is no trace of dissymmetry with respect to time—there is no "running-down" process here.

Yet we may have a typical irreversible process. Suppose that the shutter is closed so as to trap a particular distribution, say all three molecules on the left. We become familiar with this one distribution and wish to study it further, but accidentally the shutter is opened, and instead of the one distribution, we have all eight succeeding one another in a random way. This is a complete analogy to the overturn of the flask of alcohol. If we desire once more to obtain and keep the one distribution in which all the molecules are on the left-hand side of the cylinder, we may exercise our prerogatives as Maxwell demons by closing the shutter from time to time and determining by spectroscopic means or otherwise which distribution is trapped. In about eight trials we shall obtain the desired result. Unless, however, there is in sentient beings the power to defy the second law of thermodynamics, we shall find that this method of obtaining the desired distribution requires at least as much work as the old-fashioned thermodynamical method of forcing the system into the particular distribution without the aid of demoniacal devices. This classical method consists in slowly pushing a piston from the extreme right of the cylinder as far as the middle wall. In this typical reversible process the work required to overcome the pressure of the three molecules is $3\ k\ T \ln 2 = k\ T \ln 8$. At the same time the entropy of the gas is diminished by $3\ k \ln 2$.

If we wish to obtain any other one of the particular distributions, from the general distribution, the same amount of work is required. Suppose the particular distribution desired is B on the left, A and C on the right. At the extreme left we have a piston permeable only to B, and at the extreme right a piston permeable only to A and C, and these pistons are moved slowly to the middle wall. We thus obtain the given distribution, and the sum of the work done upon the two pistons is $3\ k\ T \ln 2$. In every case, in passing from the general distribution to a particular known distribution, the gas loses entropy in the amount $3\ k \ln 2$. All these processes are completely reversible. If we start with any known distribution and let the proper pistons move outward from the center to the ends of the cylinder, we obtain the general distribution, the system does work in the amount $3\ k\ T \ln 2$, and the entropy of the gas increases by $3\ k \ln 2$.

The entropy of the general unknown distribution is greater than the entropy of any one known distribution by $3\ k \ln 2$. This, therefore, is the increase in entropy in the irreversible process which occurs when, after trapping any one *known* distribution, we open the shutter. It is evident, however, that the mere trapping of one distribution makes no change in the entropy, for the shutter may be made as frictionless as we please, and the mere act of opening or closing it will not change the entropy of the system. If we start with the shutter open, with all the eight distributions occurring one after another, and then close the shutter, the system is trapped in one distribution, but there is no change of entropy.

Whence we have now reached our most important conclusion. The increase in entropy comes when a *known* distribution goes over into an *unknown* distribution. The loss, which is characteristic of an irreversible process, is *loss of information.* In the simplest case, if we have one molecule which must be in one of two flasks, the entropy becomes less by $k \ln 2$, if we know which is the flask in which the molecule is trapped.

Gain in entropy always means loss of information, and nothing more. It is a subjective concept, but we can express it in its least subjective form, as follows. If, on a page, we read the description of a physicochemical system, together with certain data which help to specify the system, the entropy of the system is determined by these specifications. If any of the essential data are erased, the entropy becomes greater; if any essential data are added, the entropy becomes less. Nothing further is needed to show that the irreversible process neither implies one-way time, nor has any other temporal implications. Time is not one of the variables of pure thermodynamics.

THE THEORY OF RADIATION

The laws of optics are entirely symmetrical with respect to the emission and absorption of light. The whole science of optics leaves nothing to be desired with respect to symmetry in time. When time is considered reversed, the emitting and absorbing objects merely exchange rôles, but the optical laws remain unchanged. On the other hand, the physical theories concerning the radiation from a particle, which were for a long time current, introduced the idea of one-way time in a notable manner. Let us quote once more from the note book of Dr. X.

"It has always been conceived that a particle which has been set in vibration, perhaps by collision with another particle, dissipates its energy in a continuous expanding spherical shell, every part of which moves steadily out into space until it meets an absorbing body. Since the energy all comes from the vibrational energy of one particle, the whole is regarded as a unitary process, although those parts of the shell of energy which meet neighboring objects may be absorbed within a very small fraction of a second, while other portions may travel years before they meet an absorbing object. The exact physical reversal of such a process is quite unthinkable. We should be obliged to imagine some prearrangement whereby each of a number of bodies far and near would, at the appropriate time and in the right direction, send out its quota of energy, all of which in the neighborhood of the absorbing particle would coalesce into a continuous spherical shell. As a rare event it might by chance occur that something approximating to this picture would be observed, but in no case could an exact reversal of the assumed process of radiation be found.

"The emission of a continuous spherical shell of energy is essentially irreversible in time, like the diffusion of continuous media which we have previously discussed. But we shall still be in trouble even if we assume that the energy radiating from a particle does not spread as a continuous shell, but goes to a limited number of other particles. Assume that a central particle emits energy to a number of other particles, and that its oscillations are damped as it loses energy, according to some simple law. The amounts of energy received by the several particles and the time of receipt are assumed to be causally connected, since the energy all flows from the one simply damped central atom.

"The exact temporal reverse either of this process or of this explanation is absurd. It would be necessary to imagine a central atom which receives energy from other atoms in such amounts and at such times as to increase continuously the oscillations of the central atom, according to a law exactly opposite to the law of damping; and we should be obliged to explain this phenomenon by saying that the amounts of energy emitted by the several particles, and the time of their emission, are all causally connected, by the fact that the energy is all to be received, and in a specified manner, by the central atom.

"After many considerations of this character I have come to the conclusion that the only process of radiation which can be harmonized with the symmetry of time is a process in which a single emitting particle at any one time sends its energy to only one receiving particle."

I think we may now agree that Dr. X was right and that if we are to assume the principle of symmetry in time, we are led irresistibly to a theory of radiation which has some of the characteristics of Einstein's theory of the light quantum. In particular we can not admit the possibility, now occasionally assumed, that in a single quantum process an atom may emit two photons to two separate atoms. Furthermore, in this theory of radiation we must assign to the emitting and to the absorbing atom equal and coordinate rôles with respect to the act of transmission of light, as I proposed in my former paper.

ELECTROMAGNETICS

Our friend Dr. X was eminently satisfied with the development of the theory of electricity and magnetism. He saw that the equations of Maxwell would be equally valid if time were reversed, and was therefore bewildered by Maxwell's deductions from these equations of a theory of radiation which, from his point of view, had all the faults of previous theories. How was it possible to obtain the old one-way theory of radiation from equations which involve nothing but symmetrical time? He did not see the full answer to this question until the development of the theory of *retarded potentials*. Then he realized that in the mathematical treatment of the problem two symmetrical solutions arose, of which one was arbitrarily discarded because it seemed inconsistent with common notions of causality.

In the whole history of physics this is the most remarkable example of the suppression by physicists of some of the consequences of their own equations, because they were not in accord with the old theory of unidirectional causality. We shall therefore attempt to analyze this problem, especially as this abstruse subject may be rendered quite simple by geometrical methods.

For this purpose Professor Wilson and I invented[8] the geometrical vector field. A vector field need not involve physical quantities such as momentum or force, but may be purely geometrical; for example, a line in space may serve to define any number of such vector fields. Thus we may, from every point in space, draw a vector along the perpendicular to the line, and with a magnitude proportional to the distance from the line.

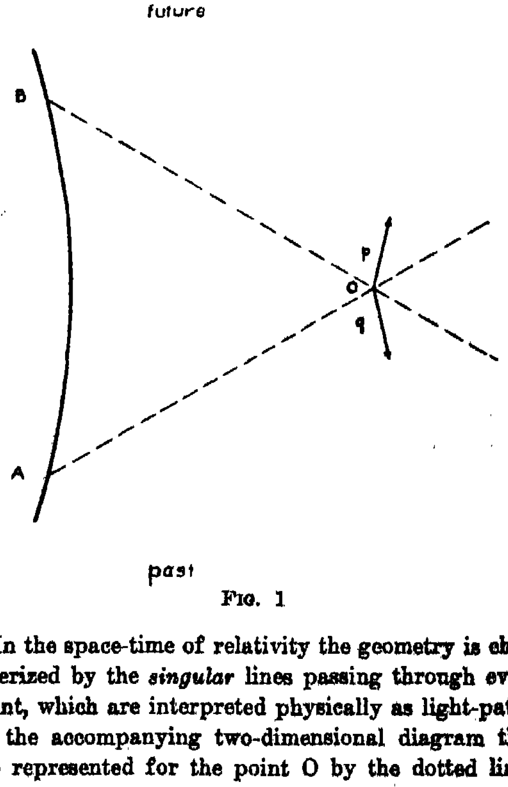

FIG. 1

In the space-time of relativity the geometry is characterized by the *singular* lines passing through every point, which are interpreted physically as light-paths. In the accompanying two-dimensional diagram they are represented for the point O by the dotted lines. In this geometry we set up the following vector field. Given any curve of the type AB, as the source of the field, then at any point O through which pass the singular lines OA and OB, the vector p is drawn upwards, parallel to the tangent of the curve at A, and with a magnitude which is the reciprocal of the distance from O to that tangent. The geometrical field thus set up has very remarkable properties. Our rules determine the variation of p in the neighborhood of O, and thus all its derivatives. The equations obtained are identical with all the complicated equations of the electromagnetic field produced by a moving and accelerated charge. This parallelism becomes an identity when we consider the curve AB as the locus in space-time of an electrical charge, and multiply the vector p by the magnitude of the charge. This vector, when projected upon a chosen time-axis, and upon the corresponding space, gives the scalar and the vector parts of the so-called retarded potential. It was so named because the influence of the charge at A was supposed to travel outward with the velocity of light and reach the point O at a later time.

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[8] *Proc. Amer. Acad.*, 48: 389, 1921.

Returning, however, to our geometry, we see that since there is no distinction between up and down, it is quite impossible to define the vector p without at the same time defining the vector q, which is drawn downward parallel to the curve at B. The projections of the vector q (multiplied by the charge) are quantities which have occasionally been studied under the name of *advanced potentials.* If they alone had been employed, the retarded potentials being discarded, we should have had an electromagnetic theory of light which would have been in equally good agreement with experimental facts, but in the interpretation of which we should have been obliged to regard the absorbing particle as the active agent, sucking in energy from all parts of space, in a spherical shell which contracts with the velocity of light.

As we now know, neither of these two electromagnetic theories is correct, and they can be used only as analogues; but in using such analogues we must hereafter give equal and symmetrical consideration to the retarded and to the advanced potentials; which means that in any theory of light we must consider the emitting and receiving agents as of coordinate importance. Thus, for example, if we wish to consider the probability that an atom X will emit a photon to an atom Y, and for this purpose imagine a virtual field produced by the particle X because of something analogous to its retarded potential, we must at the same time consider the particle Y as the seat of another virtual field of the advanced instead of the retarded type, and these two fields must be combined in a symmetrical manner to give the probability in question.

In recent months attempts have been made to extend quantum mechanics to the electromagnetic field, and here again the retarded potentials have been employed. We may safely predict that such attempts will not fully succeed until the retarded and advanced potentials are used simultaneously and symmetrically.

APPLICATIONS TO NEW PROBLEMS

We have seen that if science long ago had accepted the principle of symmetry in time, it would have eliminated the idea of unidirectional causality which has led to so many of the errors of classical physics. From this principle could have been deduced the atomic structure of matter and the newer thermodynamics. By its aid the flaws in the older theories of radiation and in the electromagnetic theory would have been seen. Moreover, the idea that light passes only from one particle to one particle, and that in this process the emitting and receiving atoms play coordinate parts, was directly derivable from the law of the symmetry of time. Let us now see whether there are new and unsettled problems which may be similarly solved.

Of the utmost importance to chemistry is the problem of reaction rates. Knowing only the state of equilibrium in a chemical reaction we know nothing of the rates of the individual reactions; but if we know the laws governing the rate of a reaction in both directions we may calculate the conditions of equilibrium. We now find that the complex problem of reaction rates may be reduced to the simpler problem of the transition probabilities between two elementary states. It will be a long time before many of these transition probabilities or intrinsic reaction rates can be calculated, but we shall see that there is one fundamental law that governs them.

When we say that we have chemical or thermal equilibrium, we mean that the average amount of each chemical substance (and also the number of particles of each species lying within a specified region, such as a region of energy), on the average remains constant. If, for example, substances A, B and C can change one into another the amount of each of these substances in equilibrium will not change, but thermodynamics alone tells us nothing of the paths by which they may go. For example, we might assume rapid processes from A to B, B to C and C to A, and slow processes for the reverse direction, A to C, C to B and B to A. There has, however, been a growing tendency to regard as impossible all such "cyclic equilibria." The principle was used in a limited way by Boltzmann, and was taken over in the quantum theory of the kinetics of gases. There was, however, a few years ago, a general disinclination to extend the principle to systems involving radiation. I believe I was the first to set up this principle[4] as a universal law in all physics and chemistry, applicable not only to chemical and physical processes involving material substances, but also to processes involving light. I called it the principle of entire equilibrium. It has also been called the principle of microscopic reversibility and the principle of detailed balancing. It states that in equilibrium the rate of change along every detailed path is equal to the reverse rate.

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[4] *Proc. Nat. Acad. Sci.*, 11: 179, 1925.

Led to the formulation of this law by the idea of symmetry in time, which I was then beginning to develop, I remarked, "The law of entire equilibrium might have been called the law of reversibility to the last detail. If we should consider any one of the elementary processes which are occurring in a system at equilibrium, and could, let us say, obtain a moving-picture film for such a process, then this film reeled backward would present an equally accurate picture of a reverse process which is also occurring in the system and with equal frequency. Therefore in any system at equilibrium, time must lose the unidirectional character which plays so important a part in the development of the time concept. In a state of equilibrium there is no essential difference between backward and forward direction in time, or, in other words, there is complete symmetry with respect to past and future."

Indeed, we can readily see that any cyclic equilibrium would mean dissymmetry in time, for, suppose that in the case cited above we could say that the process occurring followed chiefly the route ABCAB . . . , then if time were reversed, we should obtain the opposite rule, namely that the main route would be ACBAC . . . .

Consider for any system the completely detailed quantum states designated as *a, b, c* . . . , the law of entire equilibrium states that the system changes from *a* to *b* as often as from *b* to *a*. Now the chance of a transition from *a* to *b* is proportional to the probability, p_a, of finding the system in *a* multiplied by an intrinsic probability, φ_{ab}, that when the system is in *a*, it will go over in a given time to *b*. The law of entire equilibrium therefore states that

$$p_a\varphi_{ab} = p_b\varphi_{ba} \tag{1}$$

Let us now examine these intrinsic probabilities, φ_{ab} and φ_{ba}. There seems at first sight nothing in the symmetry of time to restrict the values of these quantities. Supposing for the moment that these are the only two states, and assuming that, on the average, the system remains twice as long in the state *a* as in the state *b*, the same would be true if time were reversed. A moving-picture representing the successive changes would look the same if it were run in either direction. However, science can not rest content with such a statement regarding the intrinsic probabilities; it immediately inquires what physical quantities determine these probabilities.

According to the old idea of causality, the probability of a transition would be determined by the properties of the state which existed *before* the transition. In other words, the probability of the transition $a \rightarrow b$ would be some function of the properties of the state *a*, and the transition $b \rightarrow a$ would be the same function of the corresponding properties of the state *b*. Such a view is no longer permissible. If a transition depends upon the properties of the state preceding the transition, it must in equal measure depend upon the properties of the state following, so that φ_{ab} must be a symmetrical function of the properties of *a* and *b*. Since φ_{ba} must be taken as the same symmetrical function of the same properties, we obtain immediately the most fundamental law of physical and chemical processes,

$$\varphi_{ab} = \varphi_{ba} \tag{2}$$

This law stating the equality of direct and reverse transition probabilities has received no name, except in so far as it has occasionally been confused with the law stated in equation (1). We may call it the law of the mutuality of elementary processes, or, more simply, the mutuality principle. The name is intended to suggest the important fact that a transition in one direction and a transition in the opposite direction are not two physical entities, but one entity looked upon in two ways. Whatever we can say of one process, we can say of the other. We may think of a double arrow rather than of two arrows pointing in opposite directions. At present the law is best illustrated by some of the equations of quantum mechanics, such as the equations of Schrödinger in which transition probabilities are expressed as symmetrical functions of the "proper functions" of two states.

The law of mutuality holds for the elementary states, or, in other words, for the completely specified quantum states of a system. When a system is said to be in a condition which comprises a number of elementary states, the probability of a transition from one such condition to another depends not only upon the properties of the elementary states, but also upon their number. Thus, for example, if condition α comprises only one elementary state *a* and condition β comprises the two elementary states *b* and *c*, the probability of a transition $\alpha \rightarrow \beta$ is the sum of φ_{ab} and φ_{ba}, but if the system is in the condition β the probability of the reverse transition is not $\varphi_{ba} + \varphi_{ca}$ but is less, owing to the fact that when the system is in condition β it is in state *b* *or* state *c*, but not in both.

Generalizing, we may say that when we are dealing with a complicated chemical reaction in which a condition α goes into, or proceeds from, a condition β, and if we find that the specific reaction velocity is greater in the direction $\alpha \rightarrow \beta$ than in the direction $\beta \rightarrow \alpha$, it signifies that there are more elementary states comprised in the condition β than in the condition α.

By combining equations (1) and (2) we obtain a third law which is known as the equality of *a priori* probabilities and which, since it does not involve the element of time, we need discuss no further here. It is

$$p_a = p_b \qquad (3)$$

These three laws, of which, in fact, the first and third are both derivable from the second, are the fundamental laws of quantum kinetics and quantum statistics. They are at present the most important deductions from the law of the symmetry of time.

It is remarkable that so many positive conclusions result from the negative statement that physics requires no one-way time, but more important conclusions have been derived from the similar negative statements that we can not have a perpetual motion machine and that we can not determine absolute velocities. Whether the new law will be successful in leading to new and unexpected conclusions remains to be seen. At least, if accepted, it will warn us away from certain lines of thought which involve one-way time. There is at present in the study of quantum mechanics and in some interpretations of Heisenberg's uncertainty principle a tendency to introduce anew the idea of unidirectional causality. I feel convinced that this is a retrograde tendency which may introduce new errors into science.

OBITUARY

SHOSABURO WATASÉ

American zoologists of the older generation well remember the young Japanese zoologist who came to America in 1886, became Bruce Fellow in Zoology at the Johns Hopkins University, where he took his Ph.D. degree in 1890, and was successively attached to Whitman's Department in Clark University (1890–1892) and the University of Chicago (1892–1899) before his return to Japan. He was also a well-known figure at Woods Hole where he spent most of his summers in America from 1888 on. Few of the many Japanese who have begun their scientific careers in America identified themselves more closely with the country of their residence, attained such sympathetic and thorough understanding of its history and spirit, so loved its literature and that of old England, or obtained such mastery of its spoken and written language as Sho Watasé. His friends had ceased to regard him as foreign, and thought of him as a permanent acquisition, so apparently domiciled was he in American social and academic life, until his sudden decision to return to Japan and accept the chair of zoology in the University of Tokyo in 1899.

This was a total loss to American zoology, for he resumed the old way of his life as completely as he had abandoned it for over twelve years, and his only visits to America thereafter were two brief ones on scientific missions. His return to Japan cut short a line of work in which he had already obtained marked distinction, and thereafter the needs of Tokyo and Japan claimed his undivided allegiance. This little sketch of his life will serve to fill out the picture for those who knew him, and to shadow forth a notable life to those who did not have this privilege.

Watasé was born in Tokyo, November, 1862, and there also he died March 8, 1929. He came first under the influence of American educational ideas when at the age of seventeen he entered Sapporo Agricultural College, an institution organized by William Smith Clark, President of the Massachusetts Agricultural College, under a special grant of the Japanese Government in 1875. Among the members of his class (1884) were the geographer Jugo Shiga, the journalist Gentei Zumoto and the statesman Tetsuji Hayakawa. From 1884 to 1886 he studied zoology at the University of Tokyo under Mitsukuri; from 1886 to 1890 he studied with William Keith Brooks at the Johns Hopkins University, held the Bruce Fellowship and received his Ph.D. degree there in 1890. Among his fellow students there were—E. G. Conklin, T. H. Morgan and E. A. Andrews. Then followed his years at Clark University, at Woods Hole and at the University of Chicago with C. O. Whitman, until his return to the University of Tokyo in 1899. From this institution he received the degree of D.Sc. in 1899, and succeeded Mitsukuri as head of the zoological department there in 1901.

He returned to America in 1907 as Japanese delegate to the International Zoological Congress held in Boston. On his return to Japan he took with him bullfrogs, which have become established in Japan and are very generally cultivated there as an article of food. Again on a trip to India in 1909–1910 he brought back the mongoose and established it in Japan on the Okinawa Islands, where it has almost exterminated venomous snakes which formerly caused serious loss of life. In 1922 on the occasion of another trip to the United States and Canada he investigated fox-breeding, and introduced the practice into Japan.

His interest in the domestication of wild animals was joined to an interest in their preservation in his native country, together with a life-long interest in the preservation of natural monuments in Japan. He was largely influential in the passage of laws and in the organization of a society relating to the preservation of the natural and historic monuments of Japan (1911 and 1919). Under the latter law he was put in charge of a committee on preservation of wild animal life, and worked on this subject for the remainder of his life, making a survey of some thirty-four animal species to be specially protected, including various birds, mammals, reptiles and rare marine species.

Watasé's doctoral dissertation was on "The Morphology of the Compound Eyes of Arthropods" based on a study of the structure and development of the compound eyes of Limulus with a comparison of many other representative arthropods. It was an epoch-making work in its field, and several of the artistically executed figures have long been standard illustrations of the subject. He then came under the influence of Whitman at Woods Hole and his next published work bears the marks of this influence. It deals with the cleavage of the ovum of the squid (Loligo) and was intended as the first of a series of studies on cephalopods. However, it served to introduce him to the field of cytology, and the proposed cephalopod studies were laid aside. During the remainder of his stay in America, until 1899, he devoted himself exclusively to cytological work. He had the great advantage during this time of being a member of Whitman's staff at Clark University (1890–1892), at the University of Chicago (1892–1899) and at Woods Hole. This insured him freedom for research, a situation that exactly suited his scholarly temperament. Although his activity was incessant, he did not publish much, being content to present the results of his work and thinking from time to time in the form of lectures or brief articles.

His publication on the cleavage of the egg of Loligo was a contribution of permanent significance, especially his observations on the bilaterality of the ovum and his ideas on its promorphology. The material proved excellent for the study of karyokinesis and led him into studies of the centrosome, and finally the nature of cell organization. A lecture on this subject published in the Woods Hole Biological Lectures 1893, presents the idea that the relation between the cytoplasm and nucleus of the cell is a kind of symbiosis, similar to that exhibited in the organization of a lichen. This idea, consistently and thoughtfully developed, as it is, has in it much for the fruitful consideration of modern cytologists.

In 1895 in a lecture on "The Physical Basis of Animal Phosphorescence" Watasé quotes the poet Fletcher (1637)

> You gaudy glow-worms, carrying seeming fire,
> Yet have no heat within ye!

and continues with observations from Robert Boyle (1667–1668), Faraday (1814) and others, in a way that shows his remarkable acquaintance with English literature, before proceeding with an interesting analysis of the subject in hand. This was one that satisfied both his scientific and his artistic nature, and was carried by him during the remainder of his stay in America; afterwards in Japan the subject of luminous organisms remained a favorite interest, as evidenced by his popular work in the Japanese language on this subject (1902).

In addition to the interests that he carried on in Japan already cited, he was an assiduous collector of animals and a student of ecology, which subject he studied on numerous trips to every corner of the islands of Japan; this interest led him to establish with the aid of students and friends a society for the study of the ecology of animal life of Eastern Asia.

Under a grave and serious manner Watasé was very warm hearted; he was considerate of other people and courteous in his attitude. To his students he was kindly, but never familiar; he corrected their dissertations with care and insisted on a good style of presentation.

Throughout his life Watasé was a man of many interests. During his stay in America he was one of the best read of his associates here in general literature and science; he had a lively interest in world politics, and was regarded as a special authority on Japanese art. He employed much of his leisure time in America in studying Japanese prints and paintings in various museums and libraries throughout the United States. On his return to Japan he became a member of the newly organized Institute for Japanese Arts and was a regular attendant at the monthly meetings where artists assembled to discuss and criticize Japanese paintings. He also maintained and enlarged his interest in European and American literature.

Watasé was twice married, in 1901 to Miss Yoshi, daughter of Viscount Arata Hamas, President of Tokyo Imperial University. She died in 1905, and three years later Watasé married again, the sister of one of his colleagues of the Imperial University. His home life was peaceful and happy. One of his two daughters by his first marriage and two sons by his second marriage survive him. His second wife died suddenly in August, 1928; in September of the same year Watasé himself was taken ill, but lingered on until March.

F. R. LILLIE
SHIGEO YAMANOUCHI

RECENT DEATHS

Dr. Jesse Walter Fewkes, ethnologist of the Bureau of American Ethnology from 1895 to 1917 and from 1918 until his retirement in 1928 chief of the bureau, died on May 31 in his seventy-ninth year.

Dr. George Neil Stewart, professor of experimental medicine and director of the H. K. Cushing Laboratory of Experimental Medicine at Western Reserve University, died on May 28, at the age of seventy years.

Dr. George Washington Patterson, associate dean of the College of Engineering of the University of Michigan, died on May 22, at the age of sixty-six years.

Dr. Woods Hutchinson, physician and author, died on May 26, at Brookline, Massachusetts. He was sixty-eight years old.

Dr. Benjamin A. Thomas, professor of urology in the Graduate School of Medicine of the University of Pennsylvania, died on May 29, aged fifty-one years.

SCIENTIFIC EVENTS

THE CONVERSAZIONES OF THE ROYAL SOCIETY

The first of the two conversaziones given annually by the Royal Society was held at Burlington House on May 14, when the guests were received by the President, Sir Ernest Rutherford.

The exhibits, as described in the London *Times*, were scarcely as numerous as usual, and a large proportion of them came from various research institutions. The National Physical Laboratory, for instance, showed an apparatus for making friction and wear tests on pivots and jewels and a hygrometer for use in ships carrying refrigerated cargoes, while among examples of work it has carried out for the Radio Research Board it arranged a demonstration of the reception and recording of signals from the Orfordness rotating wireless beacon. The Building Research Station had on view a meter for investigating the flow of heat at a window into or out of a room, and the Research Department, Woolwich, exhibited a proposed method for the visual examination, by means of X-rays, of flaws in long cylinders, such as gun tubes or gas cylinders. The astronomical exhibits included two photographs from the Radcliffe Observatory, Oxford, of the new trans-Neptunian planet, which appeared as a minute black dot, and a recording microphotometer was sent jointly by the Solar Physics Observatory, Cambridge, and the Cambridge Instrument Company.

Dr. L. J. Spencer, of the department of mineralogy of the Natural History Museum, showed experiments illustrating the luminescence of zinc-blende when scratched or struck—a property possessed by specimens from only a few localities—and Mr. G. C. Robson, of the zoological department, had a model of a remarkable ten-armed cephalopod, the only known specimens of which were obtained in 3,000 meters off the Cape Verde Islands and in the Pacific. The control of fungal wastage in citrus and other fruits, by maintaining a certain concentration of acetaldehyde vapor in the storage atmosphere, was illustrated by the Low Temperature Station, Cambridge, and the Forest Products Research Laboratory, by means of an instrument which measures the proportion of fibrous tissue in a sample of wood, showed how anatomical methods are applied to investigating the technical properties of timber.

General attention was attracted by a series of about 80 illuminated transparent photographs, taken by Dr. Pole Evans and hand-colored by Mrs. Pole Evans, representing different types of the natural scenery of South Africa. Professor E. N. da C. Andrade demonstrated the mechanism of ridge formation in sounding tubes, Mr. L. S. B. Leakey showed the Leakey-Harper drawing machine originally designed to facilitate the accurate detailed drawing of human skulls, Mr. R. S. Whipple sent a silver geographical globe engraved at Venice in the second half of the sixteenth century, and Sir Robert Hadfield, among other exhibits, had in operation an electric furnace with heating elements composed of a new heat-resisting alloy which enables temperatures as high as 1,200° C. to be maintained continuously.

Professor D. M. S. Watson gave the usual illustrated lecture, his subject being the flight of pterodactyls.

RESEARCH BUILDING OF THE MELLON INSTITUTE

Dr. Edward R. Weidlein, director of the Mellon Institute of Industrial Research, has announced, speaking for the Board of Trustees, that the institution is to increase its facilities by a building project for its research activities. Detailed plans are now being prepared by the architects, Janssen and Cocken, of Pittsburgh, and construction will begin as soon as the drawings are completed. The Mellon-Stuart Company, also of Pittsburgh, is the general contractor.

When the present home of the institute was completed, in 1915, it was felt that the industrial fellowship procedure created by Robert Kennedy Duncan had passed from the experimental to the practical stage. The building, which was given to the institution by Andrew W. and Richard B. Mellon, incorporated the best laboratory constructional features of that period. It was thought then that it would provide adequate space for growth for many years; but for practically ten years the institute has had a waiting list of companies, often almost as long as the roster of companies whose problems were being investigated. Even the additional space afforded by Building No. 2, acquired in 1927, gave but temporary relief.

In addition to providing a greatly increased number of laboratories, the new building will give larger quarters for the general departments. The present library contains 11,000 volumes; the new library is planned to accommodate 250,000 volumes. The present department of research in pure chemistry will be expanded and facilities for pure research in other branches of science will be provided. Much more elaborate chemical engineering laboratories are to be available in the new building, and also the fellowships in each specific field of industrial research are to be grouped in suites of rooms. Certain rooms will be equipped for specialized phases of experimental technique, such as electrochemistry, spectroscopy, low-temperature studies, radiations, high-pressure experimentation, etc. Other features are a large lecture hall, a dining hall, an industrial fellowship museum and an underground garage. For the past five years members of the institute's executive staff have been visiting laboratories in America and Europe to obtain information on new features in design and equipment.

The building will be of Greek design, seven stories high, with monolithic columns along all four sides. The proportions will be approximately 300 feet by 400 feet. The main entrance, which is on the third floor, is reached by steps extending along the entire front of the building. The laboratories are to face on interior courts. The design is to be such that additional laboratory suites can be constructed in the interior courts without marring the appearance and without interfering with the original laboratory units.

SYMPOSIUM ON THE KIDNEY IN HEALTH AND DISEASE

The University of Minnesota Medical School is issuing invitations to an interesting experiment in scientific coordination, a Symposium on the Kidney in Health and Disease, to take place at the University Hospital in Minneapolis from July 7 to 18.

Dealing with a relatively well-defined subject, but with the program occupying not less than ten working days and listing a considerable number of speakers of distinction, the symposium aims at a presentation and integration of the motley collection of material from anatomy, physiology, pathology, biochemistry, ophthalmology, internal medicine and pharmacology that make up our knowledge of Bright's disease. No attempt will be made to present the entire knowledge of the kidney in health and disease, but an effort will be made to discuss those chapters where our knowledge has recently been extended in an important way or where progress has been difficult to achieve, but investigative efforts are intense. The program is composed of papers, clinics and round table discussions. Among the different topics we pick at random the relationship between kidney structure and function, nutrition and bodily growth (G. C. Huber, C. M. Jackson, R. E. Scammon), comparative anatomy and physiology (E. K. Marshall, H. L. White), nature of glomerular function and theory of kidney secretion (A. N. Richards, P. Rehberg from Professor Krogh's laboratory, Copenhagen), chemical functions of the kidney (J. L. Gamble), functional tests (L. G. Rowntree, P. Rehberg, F. Hinman), the problem of edema (A. D. Hirschfelder, L. Leiter, B. Hastings, P. Rehberg), the pathological anatomy of Bright's disease (E. T. Bell), its clinical manifestations (F. Volhard of Frankfort on Main, I. Snapper of Amsterdam, W. T. Longcope), the retinal changes in nephritis (H. P. Wagener), uremia (F. Volhard, Butler of K. D. Blackfan's Clinic), diuretics and treatment (R. N. Bieter, L. G. Rowntree, N. M. Keith, F. Volhard).

The final program will be issued shortly. Information in regard to the symposium may be obtained from Dr. Hilding Berglund, University Hospital, Minneapolis, Minnesota. Accommodations for visitors are being provided through the university.

THE PACIFIC DIVISION OF THE AMERICAN ASSOCIATION

The annual meeting of the Pacific Division of the American Association for the Advancement of Science will be held at the University of Oregon from June 18 to 21.

The "Origin of Land Plants" is the subject of the annual president's address by Dr. Douglas H. Campbell, of Stanford University, which will be given on Wednesday morning.

A review of the progress of research on the Pacific coast and in the far west will open the session Wednesday afternoon, June 18. Dr. Richard B. Dillehunt, dean of the University of Oregon medical school in Portland, and Dr. C. B. Lipman, University of California, will survey the field of the life sciences. Dr. J. A. Anderson, of the Mount Wilson Observatory, and Dr. R. B. Brode, of the University of California, will describe the principal accomplishments in the physical sciences. The sound film of Sir William Bragg, "Arrangement of Atoms and Molecules in Crystals," and the film by C. W. Hewlett on "Radioactive Rays," have been secured for this opening session.

A feature of the meeting will be a symposium on trees, on Thursday morning. Among those taking part are Dr. Wilson Compton, secretary-manager of the National Lumber Manufacturers' Association, Washington, D. C.; Dr. Thornton T. Munger, Portland, director of the Pacific Northwest Forest Experiment Station, and Dr. A. E. Douglass, director of the Steward Observatory, University of Arizona. Dr. W. F. G. Swann, director of the Bartol Research Foundation of the Franklin Institute, Swarthmore, Pennsylvania, will address the meeting on Friday evening on "Philosophic Concepts of Modern Physics."

Friday afternoon will be devoted to a tour of inspection of the Oregon State Agricultural College at Corvallis. Several excursions have been planned to places of scientific and scenic interest. These include a trip to Coos Bay, where the university is contemplating the establishment of a biological laboratory; a trip over the McKenzie Highway to the summit of the Cascade Range, to view geological features; a geographical trip to the coast to Newport and Yaquima Bay; a third trip will take in the various lumber mills and logging camps near Eugene; a paleobotany trip will be made to the fossil beds about eight miles south of Eugene; a tour of inspection to the Springfield Booth-Kelly lumber mill will be made; the new municipal power plant and dam recently completed at Leaburg will be the subject of the seventh trip. President and Mrs. Arnold Bennett Hall, of the University of Oregon, will hold a reception on Wednesday afternoon.

Members resident in Montana and Wyoming desirous of attending this meeting may benefit from the reduced transportation rates secured under the identification-certificate plan. These certificates may be secured from the secretary of the Pacific Division, American Association for the Advancement of Science, Stanford University, California. Requests should be made immediately. Identification-certificates to members resident in California, Oregon, Washington, Nevada, Utah, Idaho and British Columbia will be sent out with the programs. Identification-certificates to non-members of the association who propose to attend the meeting will be issued on request.

SCIENTIFIC NOTES AND NEWS

A special feature of the meeting of the American Medical Association to be held at Detroit this month will be the presentation to all the living ex-presidents of the American Medical Association of an emblem significant of medical science. The four senior presidents are Dr. W. W. Keen, Philadelphia, president in 1900; Dr. Frank Billings, Chicago, 1902; Dr. W. J. Mayo, Rochester, Minnesota, 1906, and Dr. W. H. Welch, Baltimore, 1910.

A portrait bust of Professor James Henry Breasted, director of the Oriental Institute of the University of Chicago, will be cast in bronze by the French sculptor, Numa Patlagean, in Paris, and will be installed in the new building of the Oriental Institute.

The engineering faculty of New York University gave a dinner on May 28 in honor of Dean Charles H. Snow, who is retiring after thirty-eight years with New York University, thirty-three of them as head of the Engineering College.

At the third organization dinner of the Brooklyn Botanic Garden an illuminated and framed parchment scroll was presented to the director, signed by the staff and employees of the garden, fifty-four in number. The scroll reads: "Presented to Dr. C. Stuart Gager on May twenty-second, nineteen hundred and thirty, to mark the twentieth year of his association with the Brooklyn Botanic Garden as its director. This scroll is an expression of admiration for the work that he has accomplished and of the respect and affection with which he is regarded by the entire personnel of the Brooklyn Botanic Garden."

Dr. Francis E. Lloyd, Macdonald professor of botany at McGill University, has been elected a corresponding member of the Czechoslovak Botanical Society.

The Royal Geographical Society has awarded its Cuthbert-Peet Grant for 1929 to Mr. Owen Lattimore for his travels in Mongolia and Sinkiang recorded in his recently published book "The Desert Road to Turkestan."

A portrait of Professor H. F. Newall, who recently retired from the chair of astrophysics at the University of Cambridge, was presented to the university on May 10. The portrait was painted by Mr. Fiddes Watt and the presentation was made by Sir J. J. Thomson. Sir Frank Dyson and Sir Joseph Larmor spoke in appreciation of Dr. Newall's work.

IT is stated in *Nature* that the Royal Society of Edinburgh has made the following awards: Keith Prize for the period 1927–29, to Dr. Christina C. Miller, for her papers on the slow oxidation of phosphorus trioxide, published in the *Proceedings* within the period of the award, and in consideration of subsequent developments on slow oxidation of phosphorus, published elsewhere; the Neill Prize for the period 1927–29, to Professor E. B. Bailey, in recognition of his contributions to the geology of Scotland, two of which have recently appeared in the *Transactions* of the society; the James Scott Prize for the period 1927–30, to Professor Niels Bohr, who delivered an address, according to the terms of the award, on May 26.

AT the anniversary meeting of the Royal Society of South Africa, Dr. W. A. Jolly, dean of the medical faculty at the University of Cape Town, was elected president.

AT the seventh annual meeting of the American Society of Stomatology held in New York on April 10 and 11, elections were made as follows: Dr. Lloyd L. Baker, Eugene, Oregon, *president;* Dr. N. P. Norman, New York, *vice-president;* Dr. Alfred J. Asgis, New York, *editor-secretary;* Vida A. Latham, Chicago, and Dr. A. T. Rasmussen, La Crosse, Wisconsin, *fellows;* Professor Oliver T. Osborne, Yale University; Professor J. Chompret, director, stomatology division, St. Louis Hospital, Paris; Professor A. Herpin, Paris; Professor G. Coen-Cagli, University of Rome; Professor Antoni Cieszynski, University of Lwow, *honorary fellows.*

OFFICERS elected at the annual meeting in Atlantic City of the American Laryngological, Rhinological and Otological Society were: Dr. Max Goldstein, St. Louis, *president;* Dr. Coulter G. Charlton, Atlantic City, *vice-president;* Dr. W. Likely Simpson, Memphis, Tennessee, *chairman of the Southern Section;* Dr. Albert C. Furstenburg, Ann Arbor, Michigan, *chairman of the Middle Section;* Dr. Claudet Uren, Omaha, Nebraska, *chairman of the Mid-Western Section;* Dr. A. T. Wanamaker, Seattle, Washington, *chairman of the Western Section;* Dr. Robert L. Loughran, New York, *secretary;* Dr. Ewing W. Day, Pittsburgh, *treasurer,* and Dr. George I. Richards, Fall River, Massachusetts, *editor.*

DR. LOUIS KAHLENBERG, professor of chemistry at the University of Wisconsin, was elected president of the American Electrochemical Society at the recent meeting in St. Louis. Other officers elected were Bradley Stoughton, Hugh S. Taylor and George W. Vinal, *vice-presidents;* D. A. Pritchard, M. R. Thompson and Alexander Lowy, *managers;* Acheson Smith, *treasurer,* and Colin G. Fink, *secretary.*

DR. HOMER H. LOWRY, research chemist with the Bell Telephone Laboratories, Inc., New York City, has been selected as director of the recently founded Coal Research Laboratory of the Carnegie Institute of Technology.

DR. WILLIAM F. THOMPSON, director of the International Fisheries Commission, with scientific headquarters at the University of Washington, has accepted the newly created post of research professor of fisheries. His new work will not conflict with his duties on the commission, which is jointly supported by the United States and Canada for the study of the halibut fisheries, particularly in the North Pacific. Under the new plan, which will go into effect next October, the oceanographic work at the university will coordinate studies in the biology of the sea, including plant and animal life, the chemistry of the ocean waters and the geological structure of submarine areas and ocean currents. The present College of Fisheries will be consolidated with the College of Sciences to give students a more thorough scientific foundation for the study of marine animal life.

DR. H. E. WHITE, international research fellow at the Physikalisch-Technische Reichsanstalt, Charlottenburg, has accepted a position as assistant professor of physics at the University of California. Dr. White will begin his duties at California with the opening of the fall semester in August.

PROFESSOR MAX F. MEYER, of the University of Missouri, has been appointed research professor of psychology for one year, and has been relieved from all his teaching and administrative duties. His work will be concerned with methods of teaching the deaf and will be carried on with the clinical facilities of the Central Institute for the Deaf in St. Louis.

DR. J. E. W. WALLIN, director of special education in the Baltimore public schools and lecturer at the Johns Hopkins University and Morgan College, has been appointed head of the department of psychology at Atlantic University which was recently founded at Virginia Beach.

DR. HERBERT C. HANSON, of the Colorado Agricultural College, has been appointed professor of botany and head of the department of botany in the School of Science and Literature and botanist in the Experiment Station in the North Dakota Agricultural College at Fargo. He will take up his new duties on July 1.

DR. CLARENCE A. MORRELL, formerly of the department of biochemistry of the Harvard Medical School, has taken the position of chemist-pharmacologist in the laboratory of hygiene of the Department of National Health at Ottawa, Canada.

Dr. Henry S. Sharp, instructor in geology at Columbia University, has been appointed assistant professor of geology in Denison University, Granville, Ohio.

Dr. Julia M. Shipman, instructor of geography at the University of Nebraska, has been appointed assistant professor of geography at Mount Holyoke College.

The following appointments are announced at the Iowa State College: Francis Ellis Johnson, head of the department of electrical engineering at the University of Kansas, head of the department of electrical engineering; G. W. Fox, of the University of Michigan, assistant professor of physics; H. V. Gaskill, of the Ohio State University, assistant professor of psychology; James F. Yeager, of New York University, assistant professor of physiology.

At the University of Michigan Professor E. B. Mains, of Purdue University, has been appointed professor of botany and acting director of the herbarium, effective in September. He will offer advanced work in mycology and in plant breeding for disease resistance. Professor Wm. Randolph Taylor, of the University of Pennsylvania, has been appointed professor of botany and curator of algae in the herbarium. He will remove to Ann Arbor in September. He will continue, as in the past, to conduct the summer course in algae at the Woods Hole Biological Laboratory.

At the College of the City of Detroit, Mr. and Mrs. William Borgman, Jr., instructors in the department of mathematics, have been given leave of absence for 1930–31. They expect to spend the year in graduate study in Munich, Germany. New appointments to instructorships in this department are those of Mr. William L. Duren, Jr., formerly of Tulane University, and Mr. H. H. Pixley, formerly of Bryn Mawr College.

Dr. Nels A. Bengtson, chairman of the department of geography, the University of Nebraska, will give the work in economic geography in the summer session of Columbia University. E. E. Lackey, associate professor of geography, will give courses in geography in the summer session of Western Reserve University at Cleveland.

The Kaiser Wilhelm Institute for Medicine at Heidelberg was opened on May 25. It has departments of pathology, physiology, physics and chemistry under the direction of Dr. L. von Krehl, Dr. Otto Meyerhoff, Dr. Hauffer and Dr. Kuhn, respectively.

Dr. Bruce Magill Harrison, professor of biology at the University of Southern California, will spend the summer in the interior of Borneo on a scientific expedition sponsored jointly by the University of Southern California and the Universal Pictures Corporation. Dr. Harrison will leave Los Angeles about June 5.

Dr. Herbert S. Reichle, of the department of pediatrics of the School of Medicine of Western Reserve University, has leave of absence for six months and has gone to Leipzig, where he will study under Professor Bessau. Dr. G. Richard Russell and Dr. L. P. Harsh, of the same department, are starting on August 1 for a year of European study. Dr. Russell will spend most of the time with Professor Ernst Freudenberg at the University of Marburg. Dr. Harsh will do most of his work with Professor Birk at the University of Tübingen. The department of pediatrics of the School of Medicine of Western Reserve will have two guests, beginning on September 15, Dr. Otto Beck, of the University of Tübingen, and Dr. H. Brühl, of the University of Marburg.

Dr. G. H. Hart, head of the divisions of animal husbandry and poultry husbandry of the University of California, expects to take a six months' trip in Europe. He will leave New York on June 13 with the official tour of the American Veterinary Medical Association through European countries for the purpose of studying research methods and equipment, attending the eleventh International Veterinary Medical Congress in London from August 4 to 9.

Dr. William Anderson, of the University of Aberdeen, Scotland, recently spent a week in lecturing before clinics of the School of Medicine of Western Reserve University as the guest of Dr. Elliott C. Cutler, head of the department of surgery. Before sailing Dr. Anderson planned to spend a week at the Peter Bent Brigham Hospital in Boston with Dr. Harvey Cushing.

A joint open meeting of the Eta chapter of the Sigma Delta Epsilon fraternity and the Kappa Mu Sigma was held on May 23 at the department of pathology of the University of Chicago. The speaker, Mrs. Dorothea Waley Singer, gave an address entitled "Folk Medicine." Dr. Charles Singer is giving lectures on the history of medicine at various universities in the United States.

The one hundred and eighty-sixth meeting of the Medical Research Club of the University of Illinois College of Medicine was held in Chicago on May 16. This was the annual business meeting and the guest of honor was Dr. Walter H. Eddy, professor of physiological chemistry, Teachers College, Columbia University, who spoke on the "Present Status of Vitamin B." Dr. Eddy was elected to honorary membership in the club. At the business meeting which followed, Dr. Walter J. R. Camp, assistant professor of pharmacology, was elected president for the coming year.

Professor G. W. Stewart, of the State University of Iowa, recently gave a series of four general lectures on "Modern Acoustics" to the graduate students in communication engineering, Yale University.

During the session of 1929–1930, the Mayo Foundation Chapter of Sigma Xi held seven regular meetings, the speakers and subjects being as follows: Dr. D. W. Morehouse, astronomer, Drake University, "What is Outside of Space"; Dr. George H. Parker, Harvard University, "Secretory Activity of the Nervous System"; Dr. Major G. Seelig, Washington University, St. Louis, "Animal Behavior in the Development of Medicine and Surgery"; Mr. Vilhjalmur Stefansson, "Experiences in the Arctic Region"; Dr. Harry Miles Johnson, psychologist and senior fellow, Mellon Institute, "Experimental Studies on Sleep"; Dr. Robert G. Green, associate professor of bacteriology, University of Minnesota, "Epizootic Encephalitis of Carnivorous Animals"; Dr. H. E. Robertson, Mayo Clinic, "The Colorado River."

Applications for park naturalists of various grades must be on file with the Civil Service Commission at Washington, D. C., not later than June 25, 1930. The examinations are to fill vacancies in the National Park Service of the Interior Department, for duty in the field and in positions requiring similar qualifications. The entrance salaries are $3,800 a year for park naturalist, $3,200 a year for associate park naturalist, $2,600 a year for assistant park naturalist Higher-salaried positions are filled through promotion. Competitors will not be required to report for examination at any place, but will be rated on their education and experience, and on a thesis or publications.

By the will of the late Fridtjof Nansen, $25,000 is bequeathed to the Nansen fund of the Norwegian Society of Science.

Yale University has been made the residuary legatee of the estate of Miss Mary E. Hawley, of Newtown, Connecticut, from which it is estimated that it will receive $2,000,000. There are no limiting conditions except that the income from the fund shall be applied to the "general uses and purposes of the university."

The Massachusetts Institute of Technology is the remainder legatee of the residue of the fortune of Harry B. Hunt, whose estate was appraised at $510,979 net. Mr. Hunt, who died on July 25, 1929, was for many years connected with the American Locomotive Company.

By the will of Dr. William J. Matheson, formerly president of The National Aniline and Chemical Company, $600,000 is bequeathed for medical research. In 1927 Dr. Matheson provided funds for an international survey of sleeping sickness. In his will, dated October 10, 1929, he bequeaths 4,200 shares of stock of the Corn Products Refining Company (with a present market value in excess of $400,000) to the William J. Matheson Foundation, a corporation for charitable and educational purposes which the testator intended to organize. The management of the foundation is authorized to apply the income to the encouragement and support of medical research and for any other charitable or educational purpose. Among the foundation's first activities, the will states, should be to take over or contribute to the expenses of the survey of epidemic encephalitis and similar research work now carried on by a committee of which Dr. William Darrach is chairman. The principal of a $200,000 trust fund is to be paid later to the Matheson Foundation.

To provide for a complete museum of the graphic arts in the Benjamin Franklin Memorial to be erected on the Philadelphia Parkway, Mr. A. Atwater Kent has contributed $220,000 toward the $5,000,000 fund being raised for the memorial. The section is designed to show how modern methods of recording and transmitting information have developed from the crudest efforts of mankind. It will be housed in a section of the building at the front and immediately adjacent to the memorial chamber, extending from the ground floor to the roof, and consisting of a lower floor and an upper floor with two galleries. The ground floor will contain printing presses and other heavy machinery used in the graphic arts. Above will be an exhibition starting with the earliest recorded writing of man, crude sketches on the walls of caves, the various forms of writing to be illustrated up to the invention of printing by Gutenberg, and then to present-day means and methods. Among the original exhibits will be Franklin's own composing table, original press, now owned by the Franklin Printing Company, and some of his books and the manuscripts that he printed.

The purchase of 422,737 acres of forest land at a cost of $1,202,172 has been approved by the National Forest Reservation Commission. The commission has also approved the establishment of new federal purchase units in Kentucky, Arkansas, Mississippi and Louisiana. The purchase program provides for the acquisition of a total of 539 tracts of land at an average cost of $2.84 per acre in Alabama, Pennsylvania, North and South Carolina, Tennessee, Louisiana, Georgia, Florida, Wisconsin, Michigan, West

Virginia, Virginia, Arkansas, Minnesota and New Hampshire.

PRELIMINARY examinations of eight rivers in various parts of the United States with a view to the control of their floods would be authorized under the provisions of a bill reported from the House Committee on Flood Control. The preliminary examinations, according to the accompanying report, would be made for the purpose of ascertaining what a detailed survey would cost; what federal interest, if any, is involved, and what share of the expenses, if any, should be borne by the United States. The following streams and rivers would be included in those on which the examinations would be made: The Titabawassee and Chippewa rivers in Michigan, the Mohican River in Ohio, the Hocking River in Ohio, the Mokelumne River and its tributaries in California, the Waccamaw River in North and South Carolina, the French Broad River in North Carolina, the Fox River in Wisconsin and the Cumberland River and Yellow Creek in Kentucky.

DISCUSSION

HOW OLD IS THE PLEISTOCENE?

THE exploration of the cavern known as Gypsum Cave near Las Vegas, Nevada, is yielding important information concerning those hazy and nebulous years that separate the Pleistocene and Recent periods, in other words, the domains of paleontology and archeology.

The Southwest Museum of Los Angeles and the California Institute of Technology are cooperating in this work, which is in charge of Curator M. R. Harrington, of the former institution, with Dr. Chester Stock and Dr. E. L. Furlong, of the latter, in frequent consultation.

On the paleontological side the most interesting finds thus far have been in connection with the extinct ground-sloth Nothrotherium, which is one of the typical animals of the Pleistocene. Not only the bones but also large claws with horny covering still intact have been recovered, as well as its long, coarse, tawny hair and even bits of skin all preserved by the dryness of the cave. Very unusual also are the large beds of sloth dung in which the remains of the animal are usually found imbedded. Among other Pleistocene species represented in the cave are indigenous horses and an American camel.

On the archeological side, although some remains have been found left by Early Pueblo visitors probably from the settlements in the Moapa Valley thirty or forty miles eastward and even by the more recent Paiute, most of the artifacts thus far recovered from the cave may be attributed to the Basket-makers. These are the earliest people hitherto known to have occupied the Southwest and are supposed to have flourished about 1500 B. C.

It now appears that even earlier people had visited the cave, for pieces of painted wooden dart shafts unlike Basket-maker products have appeared at considerably greater depths than the deposits yielding typical Basket-maker artifacts.

Most important of all is the gradually accumulating evidence suggesting that the earliest human visitors and the last of the sloths may have occupied the cave at the same time. None of the evidences in themselves can be called conclusive, but taken together they merit serious consideration.

For example, we have in one archeological deposit a deeply buried stratum containing large pieces of sloth dung, charcoal and scattered artifacts. In another instance we have specimens of the painted broken darts mentioned before recovered at depths below the surface of from eight to ten feet, beneath a stratum of sticks containing sloth dung and hair, and in still another instance quartzite dart points of archaic form buried in the bottom of a rockslide near the surface of which, beneath a large slab, was found a nearly perfect sloth skull.

Farther back in the cave the compact layers of sloth dung have yielded a few pieces of dart-shafts and of burnt sticks once apparently used as torches; and in the crevices of the rocks, sloth dung, bones of the sloth and artifacts have frequently been found in association, but in the last case the evidence is of less value than in the previous instances.

Should the association of man and sloth be finally established beyond doubt an interesting question arises. Shall we postulate that man existed in America twenty or thirty thousand years ago, which is the age generally attributed to the last phases of the Pleistocene, or shall we assume that Pleistocene animals and possibly conditions persisted until within ten or fifteen thousand years or possibly even less? In other words, just when did the Pleistocene end?

M. R. HARRINGTON

Since the foregoing article was written, Mr. Harrington has discovered in Gypsum Cave evidence which to his mind "establishes the association of man and the sloth beyond question." The Southwest Museum, which owns Gypsum Cave, will endeavor to preserve the evidence in situ, without disturbance, so that any well-accredited scientists who feel so disposed may investigate it at their leisure.

JAMES A. B. SCHERER

THE SOUTHWEST MUSEUM,
LOS ANGELES, CALIFORNIA

THE FUTURE OF TAXONOMY

THERE is one point in Dr. Mickel's interesting discussion[1] which seems to need further comment. He refers to the small group of taxonomic workers in Washington, "flooded with specimens of insects sent in from all parts of the country for identification, so that the amount of time that can be spent in actual research is exceedingly small." Also to the specialist on Coccidae "so loaded down with routine identification work and administrative duties that he has practically no time for research." Whatever may be said concerning the ability or industry of particular workers, we are here concerned with a matter of policy, and criticism must be directed to those "higher up"—ultimately to the highest power, the people of the United States, who permit such things to be. The truth is, however, that in the long run, even with existing facilities, it would pay to do much more revisional or monographic work. Only a few days ago I received a letter from a worker in the National Museum, explaining the difficulty of conducting exchanges, because so many of the species of a certain group were erroneously identified. Without revisional work, the museum collection may well be a source of error. Specimens come in from many workers, and it is impossible to check up the identifications as they are put away. Even specimens labeled "type" can not always be trusted, as has been shown by a National Museum specialist in a paper just published. Then again, in the absence of adequate monographs, entomologists give up the idea of determining their species, and at the same time the idea of studying them. Consequently, even when they receive names for their specimens, they often do not know the species, and will not recognize them again. The practice of wholesale determination of specimens has faults analogous to those of indiscriminate charity.

On the other hand, if, with enlarged resources, we went to work cooperatively to monograph our fauna, we could enable serious students to work up their own materials. They would, of course, find difficulties, and would be entitled to assistance from the museum or bureau, after they had tried to help themselves. This assistance would be cheerfully given, with the knowledge that it would promote study, instead of preventing it. Identifications, based on revisional work and not on the labeling of specimens, derived from various sources, in the collection, would be far easier and more accurate. Time would be saved for all concerned, except those who have been in the habit of requiring a specialist to do their work for them. Broadly, then, we need more constructive imagination.

T. D. A. COCKERELL

UNIVERSITY OF COLORADO

INACTIVITY OF CHICORY[1]

RESULTS previously reported[2] indicated absence of stimulative effect of infusions of chicory on isolated intestinal segments. Later repeated observations of no gastro-intestinal response in intact rabbits, dogs and guinea-pigs to massive doses of such infusions seem to indicate further that chicory, in the form used as a beverage ingredient, probably has no laxative effect.

Such a quantity of the root is popularly consumed that it was thought worth while to investigate other possible actions. A careful series of urine secretion determinations in man (myself) and guinea-pigs have yielded, without exception, quantitatively negative results. Intravenous or stomach tube administration of as much as 60 cc of a 20 per cent. infusion produced no observable effect or discomfort in intact guinea-pigs. Substitution of an alcoholic extract (evaporated to alcohol-free) for the infusion made no difference in the complete negativity of the findings.

The only indication of a possible drug action encountered was a tetanus-like hyperexcitability of frogs which had received the relatively tremendous dose of 2 cc of a 20 per cent. evaporated tincture (roughly equivalent to 5,600 cups of an average coffee-chicory blend in man). Administration of virtually unlimited dosage failed to elicit any comparable effect in mammals. It seems quite probable that chicory has no particular pharmacological significance as used in coffee mixtures.

CHAPMAN REYNOLDS

MARQUETTE UNIVERSITY
SCHOOL OF MEDICINE

CAN A CATFISH COUNT?

A BULLHEAD catfish (*Ameiurus nebulosus*) which had been maintained since babyhood in a twenty-three-gallon all-glass tank of still water with several others of its kind was between three and four years old when it evolved a method of entertaining itself that may be called unique considering the general absence of a spirit of play in this group of fishes.

A single spray of Canadian water-weed (*Anacharis*) trailed about a foot from the main plant, touching the glass at the rear of the tank (*i.e.*, the side away from the light). The catfish, which was called "White Whiskers" because the four "chin" barbels were white, was seen every day circling this spray. It always moved over the spray, then under, always proceeded from the left to the right of the tank, and showed a preference for making the swing an even number of times before coming to rest.

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[1] Clarence E. Mickel, "The Future of Taxonomy," SCIENCE, 71: 436, April 25, 1930.

[1] From the Departments of Physiology and Pharmacology, Marquette University School of Medicine, Milwaukee.

[2] C. Reynolds, *Proc. Soc. Exp. Biol. and Med.*, 25: 696, 1928.

Often it was observed at play when there was not time to count its motions, but on five different days its circuits in this peculiar game of solitaire were counted. On one day it played fifteen games, during which it recorded in all 115 swings around the spray. On the five days it played forty games and traced the circle 263 times!

In these forty games the fish came to rest thirteen times after completing the circle an odd number of times (from one to nineteen), but on twenty-seven occasions it recorded an even number of swings(two to sixteen).

Was it merely a matter of chance, or did the catfish derive some conscious physical satisfaction from encircling the spray an even number of times?

IDA MELLEN

NEW YORK AQUARIUM

SCIENTIFIC APPARATUS AND LABORATORY METHODS

RECORDING CEREBRAL ACTION CURRENTS

ACTION currents from the cerebral cortex of the dog have been obtained by using five stages of vacuum tube amplification recording with an oscillograph. The operation which exposed the surface of the cortex was performed under both general and local anesthesias. Records were taken after recovery of the dog from the general anesthesia. Precautions were developed which have insured the minimal operative shock. Records were made with a film speed of twenty-one inches per second.

We have succeeded in recording from at least three distinct parts of the cortex, namely, portions of the occipital lobe, areas on the boundary of the temporal and parietal lobes and from the motor areas in the frontal lobe. These action currents appear to be of the same general nature as those obtained from the peripheral nerves. There would appear to be no very essential difference between different parts of the cortex in the form or frequency of the impulses themselves. At any one point one may obtain a wide variety of temporal and intensity relationships between the impulses.

From the degree of simplicity of patterns obtained with relatively large electrodes, it is inferred that a high degree of localization of function is not the case. Our largest electrodes covered about one four-hundredth of the brain surface. It may be readily seen that this is not at all sufficient to give spatial reference to nearly all the discriminable functions that the psychologist knows. We must fall back upon temporal factors within these areas, qualitative factors there, or functional patterns involving perhaps large portions of the cortex.

In general, we get records from the so-called motor and somesthetic areas with active movements of the dog, from the somesthetic and not from the motor in passive movements and slight effects in the visual area with a change from light to dark in the room. In certain cases we obtained records from the so-called visual area during active movement of the dog. This may indicate that this so-called sensory area was in this case an integral part of the dynamic pattern which gave rise to the movement. It would appear, however, that there must be a spatial factor in this dynamic pattern in order to give a sufficiently differentiated reaction here to correspond with our experimental data. The limited complexity of the records which we obtained makes it impossible to account for all the differences in the reactions of the animal in terms simply of the type of patterns on the records. Specialization of function, that is, the existence of a spatial element in the functioning of the cortex, is a fact, but we do not know as yet the degree to which this specialization is true or its constancy over a period of time.

Further work is in progress along all the lines suggested.

S. H. BARTLEY
E. B. NEWMAN

UNIVERSITY OF KANSAS

A CONVENIENT AID IN BALANCING CENTRIFUGE TUBES

A 15-CM dental chip blower syringe of about 50 cc capacity with right-angled delivery tube has been found to be very convenient in balancing centrifuge tubes. With this syringe the rate of delivery of water is much more easily controlled than with the commonly used large dropping pipette, and it has the distinct advantage of being unbreakable. It is convenient to place it in a wide-mouthed bottle, the bulb serving to keep the water clean. The syringe is stocked by dental supply houses and retails for about seventy cents.

H. W. ESTILL

DEPARTMENT OF BACTERIOLOGY,
UNIVERSITY OF CALIFORNIA
MEDICAL SCHOOL

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE REGULAR SPRING MEETING OF THE EXECUTIVE COMMITTEE

THE executive committee of the American Association held its regular spring meeting at the Cosmos Club in Washington on Sunday, April 27, with the following members present: Cattell, Compton, Curtiss, Hildebrand, Kellogg, Lillie, Livingston, Millikan, Morgan, Wilson. There were two sessions, one in the forenoon and the other in the afternoon. The following items of business were transacted.

1. The minutes of the last meeting of the committee were reported as having been approved by mail.

2. The permanent secretary presented a report on association affairs. The new fellowship-nomination plan, adopted at the Des Moines meeting, has been put into operation. While it may need some slight modifications, it appears to work very satisfactorily, and from now on there should be very few members eligible to fellowship who do not receive nomination. In this connection fellows are reminded that any member may be nominated for fellowship by any three fellows. Blanks for such special nominations may be had from the Washington office.

About 7,000 invitations have been sent out since the Des Moines meeting, inviting non-members to become enrolled in the association. It is planned to send out about 15,000 invitations this spring, especially to engineers, and about 50,000 invitations are to be sent out next October.

A new booklet on the organization and work of the association has been prepared, also a brief circular. These may be had on request directed to the Washington office. The new booklet contains lists of members of the several section committees.

Preparations for the Cleveland meeting next winter are well advanced. The Hotel Statler has been named general-headquarters hotel for the meeting. The Cleveland Convention Bureau and the educational institutions of Cleveland are actively engaged on the preliminary arrangements. The American Statistical Association, the American Sociological Society, the American Economic Association and the American Political Science Association all report that they will meet at Cleveland in convocation week. Most of the organizations that usually meet with the association will be meeting with it at Cleveland.

3. The Texas Academy of Science was elected to be an affiliated academy.

4. To fill a vacancy in the section committee of Section D (Astronomy), caused by the recent death of Dr. Ralph H. Curtiss, the executive committee elected Dr. H. T. Stetson, of Perkins Observatory, Delaware, Ohio, to be a member of that section committee, his term of office to expire at the end of the calendar year 1930.

5. The executive committee accepted a report that "Symbols for Heat and Thermodynamics" and "Graphical Symbols for Use in Radio Communication" had been approved for the association by its special committee acting in cooperation with the American Standards Committee. Dr. A. E. Kennelly is chairman of the special committee of the association.

6. The sum of $500 was appropriated, from the available funds of the treasury, for the cooperative project of the committee on the place of science in education (Dr. Otis W. Caldwell, *chairman*). This appropriation is to be added to the funds already raised by the committee on the place of science, to be disbursed by the permanent secretary on order of Dr. Caldwell.

7. On recommendation of the executive committee of the Pacific Division, the description of the territory of that division was modified to read as follows: "The Pacific Division (organized in 1915) includes members resident in Alaska, British Columbia, Washington, Oregon, California, Idaho, Nevada, Utah and the Hawaiian Islands." This constitutes an amendment to Article VI, Section 2, of the By-Laws and Rules of Procedure. Mexico, the Philippine Islands and other islands of the Pacific were included in the territory of the division and these regions are now removed.

8. It was voted that Dr. Carl Alsberg be asked to serve on the executive committee in the place of Dr. Joel H. Hildebrand during the latter's absence from the country.

9. A special committee was appointed to consider the relations between the natural sciences and the social and economic sciences in the Pacific region. This committee consists of Carl Alsberg (*chairman*), Arnold B. Hall, A. O. Leuschner, Charles B. Lipman and E. G. Martin.

10. The rules for the award of the American Association prize of $1,000 were modified by the following amendment: The award is to be first announced in connection with the meeting following the one at which the paper appeared on the program and the subject of the paper is to be specially presented in a public lecture at that meeting.

11. The rules for the award of the American Association prize were amended as follows: Papers by invited speakers and presidential and vice-presidential addresses are not eligible for the prize.

12. It was voted that the summer meeting of the association for 1931 shall be held at Pasadena, probably in the third week of June, the hosts for the meeting being the California Institute of Technology, the Mount Wilson Observatory and the Huntington Library.

13. It was voted that the winter meeting of 1931–32 shall be held at New Orleans from Monday, December 28, 1931, to Saturday, January 2, 1932.

14. It was voted that the association looks with favor upon New Haven as the place of the summer meeting of 1932 and upon San Francisco as the place of the summer meeting of 1934.

15. The general plan for radio talks to be given from time to time under the auspices of the Association Press Service was approved, as presented by the director of the Press Service.

16. In response to a suggestion from the director of the Press Service, Austin H. Clark, a special committee was named to consider the relations of the approaching New Orleans meeting to Latin America and to present plans for that aspect of the meeting. This special committee consists of Austin H. Clark (*chairman*), A. V. Kidder and Burton E. Livingston. It was empowered to add to its membership if additions seem desirable and was asked to present a report to the executive committee at its fall meeting, next October.

17. President Thomas H. Morgan was appointed to be the official representative of the American Association at the approaching semi-centennial of the University of Southern California, June 4 to 6, 1930.

18. Dr. Vernon Kellogg was appointed to be the official representative of the American Association at the tenth session of the Centenary of the Independence of Belgium, to be held at Brussels from June 28 to July 2, 1930.

19. A special committee, consisting of Austin H. Clark (*chairman*), Dayton C. Miller and Burton E. Livingston, was named to arrange for general and popular lectures for the approaching Cleveland meeting.

20. The appointment of Dr. H. W. Mountcastle as executive secretary of the Cleveland local committees was approved by the executive committee.

21. The permanent secretary asked that he be released from that office at as early a date as might be practicable, stating that he desired to devote more time and attention to his own field of plant physiology than would be possible in connection with his association duties, and a special committee, consisting of J. McK. Cattell, Edwin B. Wilson and Burton E. Livingston, was appointed to study the general administration of the association with respect to the retirement of the present permanent secretary and to report to the executive committee at its next meeting.

22. It was voted that the next meeting of the executive committee would occur at Washington on October 19, 1930.

Burton E. Livingston,
Permanent Secretary

SPECIAL ARTICLES

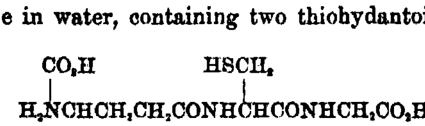
THE STRUCTURE OF GLUTATHIONE

Recently, clear evidence has come from two independent sources[1,2] that glutathione is a tripeptide derived from glutamic acid, cysteine and glycine. Twelve such dipeptides are possible. Six of these are eliminated by the fact[3,2] that the free amino group is that of glutamic acid.

The fact that Hopkins[1] obtained glycylcysteine anhydride by boiling glutathione with water is extremely strong evidence that glycine and cysteine are directly linked, and this consideration eliminates the two structures[4] in which both carboxyl groups of glutamic acid are involved. A study of the products obtained on oxidation with hydrogen peroxide[3,2] strongly suggests that it is the γ-carboxyl of glutamic acid which is concerned in peptide formation. Thus glutathione is a peptide of unique type and must apparently be either (A) γ-glutamylglycylcysteine or (B) γ-glutamylcysteylglycine.

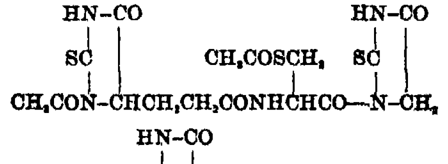
The proof that the substance is correctly represented by formula B has now been obtained by its condensation with ammonium thiocyanate in acetic anhydride, which yields a product (C), nearly insoluble in water, containing two thiohydantoin rings.

B

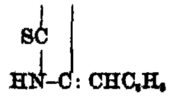


$$\mathrm{H_2\overset{\overset{CO_2H}{|}}{N}CHCH_2CH_2CONH\overset{\overset{HSCH_2}{|}}{C}HCONHCH_2CO_2H}$$

C



D



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[1] F. G. Hopkins, *J. Biol. Chem.*, 84: 269–320, 1929.

[2] Kendall, McKenzie and Mason, *J. Biol. Chem.*, 84: 657–74, 1929.

[3] Quastel, Stewart and Tunnicliffe, *Biochem. J.*, 17: 586–92, 1923.

[4] Kendall's tentative choice (footnote 2) of one of these structures was made before this evidence was published.

Condensation of this thiohydantoin derivative with benzaldehyde and subsequent treatment with alkali yields benzal thiohydantoin (D), and the formation of this product demonstrates[5] the presence in the original peptide of a glycine group with free carboxyl. Other considerations, not yet ripe for discussion here, suggest that a free carboxyl group belonging to cysteine is not also present. The formation of two thiohydantoin rings in the first condensation product (C) would also confirm the existence of a free α-carboxyl group in the glutamic acid residue of glutathione.

It is interesting to note that structures A and B, with a *slight* preference for B, were chosen by Pirie and Pinhey[6] on the basis of dissociation constants deduced from results obtained in the titration of glutathione.

Ben H. Nicolet

Bureau of Dairy Industry,
U. S. Department of Agriculture

TRANSMISSION CHANGES IN ULTRA-VIOLET GLASSES DURING HIGH TEMPERATURE EXPOSURE TO LIGHT

The recent keen interest in glasses transparent to ultra-violet radiation, and particularly the papers by Shrum, Patten and Smith[1] and by Stockbarger[2] in which are described certain phosphorescent and thermoluminescent properties of such glasses after exposure to ultra-violet light, suggest that some recent observations by the writers may be of interest to workers in this field.

It is well known that when some of these glasses are exposed to strong ultra-violet radiation, their transparency for the short wave-lengths is considerably decreased. It is also known that heating the solarized glasses restores them to their original condition.

In some recent experiments with several of the well-known brands the writers found that, if the specimens of glass were attached directly in contact with the hot tube of the mercury arc lamp and thus were kept at a high temperature (about 450° C.) during the ultra-violet exposure, there was no decrease in the short wave transmission, but instead, a marked increase. With one glass the shortest wave-length transmitted when new was 2535A. After solarization at atmospheric temperature, two feet from a quartz mercury arc, the transmitted spectrum was so shortened that 2620A was the low wave-length limit. When the glass, during exposure, was kept hot, the result was a very marked increase in transmission, so that wave-length 2460A was distinctly visible in the spectrogram of the transmitted radiation. This same result was obtained whether the glass had been previously solarized or not. In all cases the transmission spectra were photographed immediately after the ultra-violet exposure, the glass having cooled to room temperature. A condensed iron spark was used as the light source for testing the transmission.

All these specimens were then "annealed" in the dark at various temperatures, first at 200°, then successively at 300°, 350°, 400° and 450° C. After each annealing the glasses were cooled and their transmission spectra photographed. Even at 200° there was, in every case, indication of return toward the transmission of the original, new glass. This became more marked with increasing temperatures, until, after the 450° treatment, all had completely recovered the original condition.

On account of the fact that during the hot ultra-violet exposures there was only a line contact between the flat glass and the cylindrical lamp tube, the specimen was not uniformly heated. Examination (after cooling) with a low power polarizing microscope, between crossed nicols, showed severe strain in the glasses. This was also relieved by the subsequent annealing but had disappeared completely only after the last (450°) anneal.

Not all the ultra-violet glasses behaved in the way described. One in particular showed only a barely detectable decrease in transmission on low temperature exposure, and no change whatever after exposure in contact with the lamp tube.

C. C. Nitchie
F. C. Schmutz

Research Division,
The New Jersey Zinc Company

BOOKS RECEIVED

Hora, Sunder L. *An Aid to the Study of Hamilton Buchanan's "Gangetic Fishes."* Memoirs of the Indian Museum. Vol. IX, No. 4. Pp. (169–192). Plates (13–23). Published by the Director, Zoological Survey of India, Calcutta. 4s. 9d.

Moulton, Forest R. *Differential Equations.* Pp. xv + 395. Macmillan. $5.50.

Report on the Zoological Survey of India for the Years 1926 to 1929. Pp. lviii. Illustrated. Government of India, Central Publication Branch, Calcutta. 2s. 6d.

Sewell, R. B. Seymour. *The Copepoda of Indian Seas:* Calanoida. Memoirs of the Indian Museum. Vol. X, 1929. Pp. 221. 81 figures. Published by the Director, Zoological Survey of India, Calcutta. 13s. 9d.

Woodruff, Lorande L. *Foundations of Biology.* Fourth Edition. Pp. xvi + 501. 297 figures. Macmillan. $3.50.

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[5] Schlack and Kumpf, *Zeitschr. für physiol. Chem.*, 154: 125–70, 1926.

[6] *J. Biol. Chem.*, 84: 332, 1929.

[1] *Trans. Roy. Soc. Canada*, [3] 22: 453, 1928.

[2] *Tech. Engineering News*, December, 1929.

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THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY[1]

INSTALLATION ADDRESS

By Dr. SAMUEL W. STRATTON

RETIRING PRESIDENT AND CHAIRMAN ELECT OF THE CORPORATION

The administration of the affairs of a large educational institution has become in many respects as great a problem as that of industry. The interests of the former are generally more diversified, its organization more complex and its administration more difficult, from many points of view.

Academic freedom, which generally refers to one's right to an opinion in his own field and to teach accordingly, is often interpreted to cover a much wider range of subjects, hence we do not always find the team work in the faculty that is found in industry or in the football team. In an institution like this, the coordination of the work between departments having many common interests is one of the most important phases of administration.

Notwithstanding the many interests common to all the scientific and technical departments, there is necessarily a great diversity between them in the later years of the courses and in graduate work.

At the institute there are twenty or more undergraduate courses and options leading to degrees. In all these graduate work is going on and growing rapidly. The inter-departmental relations as to this advanced work involve administrative problems of great importance.

Every department depends upon others for instruction in some of the subjects included in its own curricula. Few research projects are taken up that do not involve cooperation as to personnel and equipment between different departments. Conditions set up for convenience in departmental organizations are not always those most favorable to investigational work. Our course in engineering administration has shown conclusively that an engineering training supplemented with the fundamentals of business is an excellent preparation for the work of administration, especially in industry.

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[1] Addresses given at Cambridge, Massachusetts, June 6, 1930.

In every group of men entering the institute, some men are found who are by nature fitted for this class of work, and special training is provided for them. Others are endowed with the spirit of discovery; when the training of these is supplemented by advanced mathematics and science, they often become research men of the highest type. To discover these types of men and prescribe suitable courses of training for them is a most important educational problem. Men succeed best when following an occupation they enjoy.

To adjust the grade of each man's work in accordance with his ability rather than a fixed minimum as a standard for all is essential to efficiency in education if we are to do the best by the men. Some can accomplish much more than others with the same effort. Why not give them the opportunity?

A question of major importance in the administration of the affairs of a professional school is that of interesting successful men in the training of those who are to follow in their professions. Among the graduates of the institute are to be found many of the foremost leaders in all the branches of science and technology with which it is concerned. These men can and do contribute the benefit of a wealth of experience. To encourage and foster this sort of contact is worthy of our most serious attention.

Cooperation with industry in this same respect is also important. Industry as well as the professions should assist in preparing the specifications of the types of men they need, and which we are in the business of training. The cost of training men in science and technology is much greater than is generally understood. When one of the early English physicists was asked by a visitor if he might see his laboratory, the physicist called a servant and directed that the laboratory be brought in. Contrast this with the great modern research laboratories, educational or industrial, with equipment for undertaking the most delicate investigations, or those requiring huge compressors, furnaces, generators or other facilities necessary to produce the conditions which the scientist of to-day must have at his disposal.

By far the most serious problem confronting an institution training men in the fields of science and technology is that of maintaining a suitable instructing staff; men who are leaders, and who inspire in others the same qualification.

During the past decade or so, many industrial concerns have learned what a few discovered earlier—the value of scientific research. During this period large numbers of young scientists have been taken into industry where they are rendering valuable service, much of it research of the highest order. Hence the supply of such men now available for educational work is very small. Naturally this demand has raised the pay of competent scientific men nearer to what they are worth and which educational institutions must meet by better pay, and especially by conditions favorable to original investigations.

It is encouraging to note that some concerns are cooperating with educational institutions in the maintenance of instructors and equipment in order to insure a supply of men who often become their most valuable asset.

To meet the mounting costs of a technical education the institute has twice raised its tuition in the past four years, which now covers about one half of the cost of instruction and expenses accessory thereto, not including buildings. We at the institute do not forget that the buildings about us and their equipment were provided for in the most part by men who are grateful for their own training and those who appreciate the part the graduates of the institute have taken in the building up of great industries.

The founders of the institute saw with prophetic vision and provided for the relation that must exist between instruction in technology and that of the basic sciences involved. They realize that progress in the fields of applied science goes hand in hand with the discovery of fundamental principles. Their most vivid imagination could not have forecast the growth of science and the consequent development in the fields of technology. Out of physics have grown:

Electrical engineering with many subdivisions, rigidly exacting as to the most advanced modern physics for a foundation.

Aeronautical engineering with its basic aerodynamics.

Modern hydraulics, involving hydrodynamics.

Geodesy, the most precise form of surveying.

Developments in steam and internal combustion engines, applications of the principles of thermodynamics.

Out of chemistry have grown:

Chemical engineering, the adaptation of chemical processes to production on a large scale. The petroleum industry owes it present success to the chemical engineer.

Physical chemistry, involving the most precise measurements of physics in the determination of constants and laws upon which progress in the science of chemistry and its application depends.

Refrigeration engineering, based upon the laws of heat transfer.

Electro-chemistry, dealing with reactions at high temperatures so essential in metallurgical and other industrial processes; also the conditions under which metals are deposited electrolytically. Out of these great industries have sprung up as if by magic.

The cryogenic field is one in which both physics and chemistry are brought to bear in the production of low temperatures, the liquefaction of gases, the production of gases essential in both science and industry. The striking laboratory experiments of a decade or two ago were the forerunners of great industries of to-day.

In the field of metallurgy, applications of physics and chemistry form one of the newest and most important branches of science and its applications. The metallurgist juggles with metals and produces mixtures at will with almost any given properties, without which many modern industrial developments would have been impossible.

This is true to an amazing extent of all the materials we use, the bricks with which we build the refractories that line the furnaces of industry, the finest porcelain, the cement, the glass and all the materials of construction.

The fuel question is the most important of the automotive industry. The clothes we wear and the papers we read involve the use of scores of materials. In connection with the use and production of all these materials, new fields of technology have arisen based upon physics and chemistry of the most fundamental nature.

It is becoming difficult to classify science as pure and applied. Engineering and technology involve the most difficult problems in the fields of pure science. .Industries are calling for and producing the most fundamental scientific data. Hence, in the training of men we must not overlook the intent of the founders of the institute as to the relations between the basic sciences and technology even though each has advanced far beyond their most sanguine vision.

To maintain the ideals of the founders and the best traditions of the institute, they must be interpreted in the light of modern science and the problems of the day. All its functions must be carried on in an atmosphere of research, if it is to be a blazer of trails to new fields and not merely the follower of beaten paths.

Recognizing these facts, the corporation has adopted a plan of organization which will permit of the administration of the affairs of the institute in accordance with the requirements of the present, and the conditions under which it can perform its functions most efficiently. This new plan provides for both a chairman of the corporation and a president of the institute; heretofore the latter has served in both capacities. In the present case the retiring president becomes chairman of the corporation, who at this time wishes to express his great appreciation of the support given him as president and the hope that these friendly, helpful relations will continue while he is its chairman.

Alumni and Friends of the Massachusetts Institute of Technology:

I have the honor of presenting to you the choice of the corporation for the next president of the Massachusetts Institute of Technology—Professor Karl Taylor Compton, chairman of the department of physics at Princeton University—eminent investigator in the field of physics, with a long list of original contributions to knowledge in this branch of science to his credit.

Honored by degrees from many institutions for his brilliant work in science.

Member of the National Academy of Sciences and an active leader in the organized bodies of American scientists.

Sympathetic with the applications of science in the fields of engineering and industry.

Who rendered most important scientific service during the late war.

And above all, a man who is universally loved and admired by all who know him.

To you, President Compton, I commend a corporation composed of successful men actively interested in the affairs of the institute. As its leader I foresee a constructive cooperation with you:

A loyal faculty, appreciative of your leadership,

A serious energetic, self-governed student body, which will be your greatest inspiration.

INAUGURAL ADDRESS

By Dr. KARL T. COMPTON

PERMIT me to take this opportunity briefly to discuss certain features of the Massachusetts Institute of Technology which have induced me, with real enthusiasm, to cast my lot with you as a part of this new organization. I venture to hope that this is appropriate because the significance of these considerations is not primarily to me personally, but to every one who is interested in science, and in the contributions which science has made and will in the future make to the happiness and welfare of mankind.

The three most pertinent questions in evaluating any institution would seem to be, "What is its purpose?" "What is its accomplishment?" "What is its future?" It is through its answers to these three questions that the Massachusetts Institute of Technology commands allegiance and support.

I venture to formulate the purpose of the institute as "the development of science and its useful applications," and to describe the method of accomplishment of this purpose as being "through continual study and research combined with the training of men." This purpose is dictated by the opportunities found in modern science for contributing in such a fundamental way to the necessities of life that it is not surprising that the distinguished founder of this institute, William Barton Rogers, expressed it and recommended the means to accomplish it in words which are every bit as significant to-day as they were when he wrote from Virginia in 1846 to his brother Henry in Boston, outlining his plan for an institute of technology. This was fifteen years before the institute was incorporated and nineteen years before it was actually opened. He says:

> The true and only practicable object of a polytechnic school is, as I conceive, the teaching, not of the minute details and manipulations of the arts, which can be done only in the workshop, but the inculcation of those scientific principles which form the basis and explanation of them; and along with this a full and methodical review of all their leading processes and operations in connection with physical laws.

Dr. Rogers then goes on to outline an organization and a curriculum which are astonishingly like those of to-day, which have stood the test of time and experience. As an example of constructive imagination, good judgment and prophetic vision, I wonder whether there is an equal to this in educational literature!

Turning now to the question, "What has been the institute's accomplishment?" I almost hesitate to attempt an answer, because its direct and indirect influence have been so enormous. As the first category of accomplishment I would mention its alumni. They comprise builders of huge industries, organizers and executives of great companies, leaders in science, engineering and architecture, and a great host of men who are ably engaged in operating and developing the vast industrial system which is the distinguishing feature of our present civilization. And in educational work they have taken an equally prominent part. For example, I recently visited a great Midwestern university in which I found that all four of the deans were Technology men. During the past few months, since I have become so particularly interested in the institute, I have been continually amazed to discover how important a rôle its alumni are playing in the life of the country. There can be no doubt regarding the value and vigor of an institute which has trained such men.

As the second category of accomplishment I would point to the other great technological and engineering schools now scattered all over this country, which are the direct offspring, so to speak, of the Massachusetts Institute of Technology and patterned after the original plan of President Rogers, each with an individuality born of local conditions or of desire particularly to emphasize one or another aspect of the general plan. In thus providing a pattern and also to a very large extent the faculties for these newer technological schools, the institute is in the position of the founder of a sturdy and illustrious family. And this is true not only in this country but also abroad. It is held, for example, that the tremendous technical and industrial development of Germany is due largely to the fact that that country, perhaps more than any other, was quick to grasp the value of President Rogers' ideas and, with characteristic efficiency, to build upon them a nationwide system of technical schools and of industrial development.

As the third category of accomplishment, I would like to suggest simply the present industrial and economic structure of the country. Of course very many factors have entered into this, and the part which the institute directly or indirectly has played is rather undefined but none the less real and of tremendous significance. Time does not permit elaboration of this interesting theme.

And finally, "What of the future?" From past experience and accomplishment we may gain wisdom, guidance and encouragement, but it is the future which vitally interests us. In regard to this future there seem to me to be several outstanding considerations.

In the first place there appears to be no reason for any change in the purposes and ideals of the institute. As I have already remarked, the institute has been devoted in the most fundamental way to the benefit of mankind through science. There is every indication that only a beginning has thus far been made in the science of discovering and understanding nature and in the art of usefully applying this knowledge. I can conceive, therefore, of no more appropriate or urgent program for the institute than simply to continue its work of developing both principles and men for applying science to problems of human welfare. But, although the purpose of the institute is unaltered, I do believe that present conditions indicate the necessity of careful attention to several vital matters.

First I would suggest the necessity of greater emphasis upon the fundamental sciences both in their own rights and as the bases of the various branches of engineering. As engineering has developed to greater and greater complexities, it becomes increasingly impossible to hope to train men in those exact processes of thought or manipulation for which they will later be called upon. And as scientific discoveries and applications are ever increasing at an accelerated rate, there is ever-increasing probability of meeting problems far off the beaten trail. Also many who start in as engineers later become executives or administrators. In all such situations a broad and thorough training in fundamental principles gives much greater power than a training in details which may seldom be encountered in practice. Again, whereas a generation ago most of our great technical industries were in their infancy and needed many men trained in the details of their respective arts, now most of these industries are large organizations which are equipped and prefer to train their own men in the fine points of their art: they absolutely require, however, men who come with a sound basis of training in fundamental principles. The institution which supplies these men supplies the men destined to leadership.

Every application of science presupposes a discovery of science to be applied, so that the useful applications of science are in the last analysis limited by the extent to which scientific research has been successful in uncovering the hidden forces of nature. Then, when these scientific discoveries are put to the service of man, there is always a limit to the available extent of this service—a limit set by some such thing as a defect of material, inability to solve an equation, or some disturbing factor. So here again it is the province of research to push back or remove these limitations. While, therefore, in its humble beginnings, the greatest service of an institute of technology might very well have been to acquaint men with the laws of science and the technique of their application, an institute of technology to-day, to perform its greatest service, must take the lead in actually developing science and its applications as well as in technological instruction. In fact no proper or adequate teaching in these days can be done except as it is permeated with the spirit of research, for every constructive activity of life which is not mere routine consists of the continual endeavor to solve problems, in which broad training in fundamental principles and the inculcation of the true spirit of research constitute the best possible preparation.

I hope, therefore, that increasing attention in the institute may be given to the fundamental sciences; that they may achieve as never before the spirit and results of research; that all courses of instruction may be examined carefully to see where training in details has been unduly emphasized at the expense of the more powerful training in all-embracing fundamental principles. Without any change of purpose or any radical change in operation, I feel that significant progress can thus be made.

Second let me emphasize the supreme necessity of maintaining a faculty of absolutely first-grade men, despite the increasing difficulty of doing so. Here, as in every organization, the question of personnel is the supreme issue. But, unlike other organizations, an educational institution can make a perfectly logical and unanswerable argument that its need of the best men should supersede the claims of any other organization. For it is these men in the educational institutions who train and inspire all the others; their abilities are renewed and made available to the world in every graduating class. The folly of sending our youth to second-rate teachers in the hope of obtaining a first-class training is too absurd to discuss. And yet this is a very real danger, for industry is competing with universities for the best men, often taking them and then perhaps later finding fault with the institution for not giving its students a first-class training! I could go on at great length on this topic, which is one so easy to argue, yet so difficult practically to solve.

Several things, I believe, conspire to make this situation so serious. Industry can outbid an educational institution for a man if it wishes to do so. An industry may be short-sighted, looking only to its profits for the next few years. Or it may realize the situation and, if left to itself, would not try to take a certain man from an educational institution—but realizing that if it does not some competing concern will, it proceeds to invite the man to join its staff. There are instances in this institute in which an industry has taken man after man from key positions, leaving a department seriously embarrassed, crippled and criticized. (In fairness I should say, on the other side, that this demand for men by industry is stimulating and is really an evidence that the institute has been successful. It would, to my mind, be nothing short of a calamity if the demand by industry for men on the faculties were to cease.)

How, then, is this complicated situation to be handled? I doubt whether any rules, agreements or other artifices can hope to solve it. The solution must be found, I think, according to the regular economic laws, that is, by the institute's being in a position to offer to the man it needs a sufficient emolument in salary and advantages to hold him or, failing that, to secure another first-class man in his place. And the industries must, for their own ultimate self-interest, see to it that the institute is financially able to retain on its staff the leaders in the various scientific and technical professions.

It has been well said that "civilization is measured by the ability to forego present pleasures for the sake of future benefits." In regard to the point which we have just been discussing, it is certain that only a few of our leading industries can be said on this basis to be civilized at all. Had it not been that many individuals have, by their generosity and vision, proved themselves "civilized" to a high degree, our technological institutions and the industries which have been so indebted to them would both now be in a pitiable state.

Just how industries can be brought to bear a fair share of the expense of giving first-class training to the men on whose discoveries and work they largely exist is a problem for the future. Certain it is, however, that its satisfactory solution would greatly accelerate the rate at which science and industry can contribute to the comforts and opportunities of life. In any case, however, the problem of personnel and financial means to maintain it at a high standard is one which presents a serious challenge.

The third problem of the future to which I should like to call attention is one which is not so fundamental as the two just discussed, but which is nevertheless very important and interesting. It is the problem of finding the most advantageous way in which the institute can cooperate with technical industries in the solving of their problems. As you know, a great step in this direction was taken with the inauguration of the so-called "Tech plan" and the formation of the division of industrial cooperation and research. Very valuable work has been done under this plan, but it has also had certain unsatisfactory features. I know from personal experience that contact of a university teacher with the practical problems of an industry can be professionally extremely stimulating and valuable. And certainly the institute should render every assistance in its power to any worthy cause within the range of its interests. The problem really consists in improving, if possible, the way in which this aid is rendered so that it may be not only as effective as possible in regard to the object of the assistance, but also done so as not to interfere with the other more fundamental activities of the institute—and if possible done so as to aid them. This problem is one requiring both study and wise counsel. Like every good problem, it presents opportunities as well as difficulties.

These problems which I have mentioned, and to which others might be added, are simply sign-posts pointing out the directions which our efforts must take in order to do our work most effectively. It is a work whose results will ultimately affect every man, woman and child and which should command the support of all except those few who are timid in the face of power or who for some reason fear to let man understand too much of nature. The Massachusetts Institute of Technology looks to us, who love and respect nature, to work out her future development. I join you in this work because I believe in its value, and for the same reason I feel confident of the coöperation of each of you, according to his position and opportunity. In its direct and indirect influence I can conceive of no more valuable service.

OBITUARY

ERNST CLEMENT ANGST

A CAREER which held every promise of distinction was terminated by the sudden death, on April 18, of Dr. Ernst Clement Angst, assistant professor of botany at the University of Oklahoma.

Dr. Angst was born in Chehalis, Washington, on February 15, 1899, of Swiss and Canadian parentage. He was educated at the University of Washington, receiving his doctorate there in 1929. He was married in 1923 to Carol Lavone Cramblitt, who survives him. From 1923 to 1927 he was a member of the faculty of the University of Idaho at Pocatello. He went to Oklahoma in 1929 and during his few months of service there won the undiluted respect and affection of his immediate colleagues and students.

In addition to published work on marine bacteria he was coauthor with Dr. H. H. Gran, of Oslo, of a monograph on the plankton diatoms of Puget Sound, now in press. At the time of his death he had collected, described and figured 145 species of Oklahoma diatoms nearly all of which were determined. This work will be completed for posthumous publication.

Dr. Angst was an unremitting investigator of the highest type, gifted with a facile and original technique and sound scientific judgment. In addition he was a splendid teacher whose lectures, erudite and methodical, were seasoned with quaint, incisive humor. His colleagues in the department considered it a privilege to listen in when they could, and it was not an unusual sight to see an entire class on the edges of its chairs. There is no question that a few more years would have seen Dr. Angst rated, not only as a great diatomist, but as a great teacher of botany.

PAUL B. SEARS
R. E. JEFFS
ADRIANCE S. FOSTER
R. H. MOORE

RECENT DEATHS

DR. W. S. FRANKLIN, who retired last year from the professorship of physics and electrical engineering at the Massachusetts Institute of Technology, was killed in an automobile accident on June 6. Dr. Franklin was driving north from Florida, where he had served during the winter as visiting professor at Rollins College. He was sixty-seven years old.

DR. A. R. CROOK, who for twenty-four years has been chief of the Illinois State Museum at Springfield, Illinois, died on May 30 at the age of sixty-six years.

DR. H. J. B. FRY, pathologist at the Cancer Hospital, London, died on May 5 from an infection acquired at a post-mortem examination. He was forty-four years of age.

MEMORIALS

To commemorate the life and work of Dr. Herbert Steuer, on the second anniversary of his death, the Steuer Memorial Prize was awarded to William A. Sommerfield, a junior in the School of Medicine of Western Reserve University. Dr. Steuer was electrocuted on June 6, 1928, while making an X-ray examination of a patient. Friends of his established the memorial, the income from which goes each year to an investigator who does meritorious work in the department of anatomy of Western Reserve University.

THE Cole Library, in memory of the late Professor Alfred Dodge Cole, in the Mendenhall Laboratory of the Ohio State University, was opened for the use of students and faculty, with the spring quarter. The library will be supported by a fund of $50,000 which is being collected by engineers and other alumni who are particularly interested in physics. More than $22,000 has already been pledged.

SCIENTIFIC EVENTS

THE PROPOSED SUBTROPICAL NATIONAL PARK IN FLORIDA

SECRETARY WILBUR, of the Department of the Interior, has announced that the departmental committee of experts designated by him to make an examination of the availability of the Everglades in the Cape Sable region of Florida for a suptropical national park has completed its investigation, and would report that the project measured up to the high standards prescribed for national park establishment.

He stated that the prospective educational value of the area equals at least, if it may not exceed, that of any existing national park, and that the area should be preserved to protect the primitive character of the country and its abounding wild life so that it may be enjoyed in its natural state by future generations as well as those of our time. For these reasons, he said, he would himself recommend it to Congress for approval as a project.

The committee of experts consisted of Director Horace M. Albright and Associate Director Arno B. Cammerer, of the National Park Service; E. K. Burlew, administrative assistant to the secretary, and acting as the latter's personal representative; Superintendent Roger W. Toll, of the Yellowstone National Park; Dr. Hermon C. Bumpus, of the American Association of Museums; Dr. T. Gilbert Pearson, president of the National Association of Audubon Societies, and Dr. M. W. Stirling, chief of the Bureau of American Ethnology.

The detailed official report embodying the committee's recommendations is in course of preparation. The announcement says:

> The Cape Sable region of Florida, site of this prospective national park, is fifty miles nearer the equator than any other section in the United States and presents an area of tropical America in flora and fauna encountered nowhere else in the United States. One interesting observation made generally by the members of the committee was that their original conception of the Everglades as an impassable tropical jungle, festooned with lianas and with miasmatic swamps, full of alligators, crocodiles and venomous snakes, was entirely shattered by their views of extensive coastal prairies and tropical hammocks. The inspection was made by dirigible, and by motor boats and skiffs.

EXPEDITION TO GREENLAND OF THE UNIVERSITY OF MICHIGAN

PROFESSOR WILLIAM H. HOBBS, of the geology department of the University of Michigan, while remaining in Ann Arbor, will direct a fourth expedition to Greenland, made possible through a recent gift of $5,000 by the Carnegie Institution of Washington for a twelve months' continuance of earlier studies. Professor Hobbs will direct the work partly by wireless.

Plans are under way for the establishment of two aerological stations—one in Ivigtut, on the western coast of south Greenland, and another in Anmagssalik, in southeastern Greenland, both south of the Arctic Circle. The Michigan observers will cooperate with Professor Alfred Wegener, who has already reached Greenland at the head of a large expedition which includes twenty scientists.

Professor Wegener will establish three similar stations stretching in a line across the ice cap of Greenland in the latitude of Umanak. One of these stations will be situated on the top of the ice cap and near the remote center of the continent. All five stations will be operated simultaneously for the period of a year, affording, for the first time, a comprehensive study of the circulation of the atmosphere above Greenland—the glacial anticyclone. The work of Dr. Wegener has been stimulated by that of the University of Michigan Greenland Expeditions and will be devoted to the same end.

Evans S. Schmelling and William S. Carlson, of the department of geology, both of whom have taken part in the former expeditions to Greenland, will be sent to the two stations. The American-Scandinavian Foundation recently awarded to Mr. Carlson a scholarship which will enable him to study, in connection with his other scientific work, the possibilities for establishing a seaplane station on the northern airplane route to Europe. Max H. Demorest, of Flint, Michigan, will accompany the two members of the expedition, as assistant.

Necessary instruments for the work will be loaned by the United States Weather Bureau. Transportation for Mr. Schmelling has been planned through the cooperation of the Pennsylvania Salt Company, operators of a ship ore line between Philadelphia and Ivigtut. The Cryolite Mining Company, which operates a mine at the site in Greenland, will provide his food and living quarters for the year.

On all clear days members of the expedition will send up pilot balloons and follow their paths with the theodolite so as to discover the force and direction of the wind at all levels up to the place the balloon passes out of sight. Dr. Wegener will be sending out similar pilot balloons at his stations.

THE PAN-AMERICAN AGRICULTURAL CONFERENCE

North America will meet Latin America in Washington next September for discussion of the problems of agriculture that affect or are common to the two continents. Officials of the U. S. Department of Agriculture, which is cooperating with the Department of State and the Pan American Union in preparing for this Inter-American Conference on Agriculture, Forestry and Animal Industry, believe it promises to be at least as important as any previous gathering for any other purpose in which the two continents have joined forces. The conference, which will be held at Washington from September 8 to 20, will be devoted to practical problems of agriculture, giving special attention to agricultural problems of an economic and scientific nature.

Called in accordance with a resolution of the Sixth International Conference of American States at Havana in February, 1928, the coming assembly will be the first Pan-American gathering to deal exclusively with questions related to agriculture. This subject has been on the program of several of the Pan-American scientific and commercial congresses, and a group of the nations concerned has discussed various phases of the problem at other meetings, but at no previous conference has an attempt been made to cover such a wide range of agricultural topics or to consider in such a comprehensive way plans looking to the scientific and economic development of agriculture and its related industries throughout all the nations of the Americas.

Problems of inter-continental concern will be discussed in their broadest scope and with a view to formulating basic plans for effective continental cooperation in the development of the agricultural industries. Both governmental agencies and private organizations will participate, and the conference will endeavor to promote cooperation between governments and private citizens in the study of the problems presented.

The conference will consider broadly the problems of research in agriculture and forest development and methods of preventing and eradicating diseases and pests affecting plants and animals. Sponsors of the conference also anticipate that in discussing agricultural economics the members will explore the problems of competition which are now beginning to bear heavily on the nations in the tropical and subtropical regions of this hemisphere. Tropical countries of other continents now offer growing competition in production of such products as rubber, coffee, sugar, cacao, cotton and other vegetable fibers, tobacco and citrus fruits. In many of these products the new world formerly enjoyed practical freedom from competition.

The conference will also consider plans looking toward a coordination of research work by groups of the American nations acting in harmony to improve and develop the crops in which they have common interests. It will study the latest scientific methods both for the growing and for the marketing of agricultural products.

Reports dealing with the various questions on the agenda have been prepared by experts and are now being sent to the national committee in the different countries and to the private associations which are being invited to attend. This will promote advance study in preparation for the discussions at the conference itself, which will be chiefly round-table gatherings.

THE SUMMER MEETING OF THE AMERICAN PHYSICAL SOCIETY

For the first time in many years the American Physical Society will hold a summer meeting. This meeting, which will be held at Cornell University, Ithaca, N. Y., from June 19 to 21, will be in the nature of a "vacation" meeting. Plans have been made to schedule the formal scientific program chiefly in the morning sessions. The afternoons will be devoted largely to informal conferences on a variety of topics concerning both experimental and theoretical physics and to sports. A picnic dinner will be held one evening in Enfield Glen, a gorge that contains many interesting geological features. One morning will be given over to the presentation of ten-minute contributed papers by members of the society. The remainder of the formal program will consist of invited papers.

At one of the sessions certain features of modern astrophysics will be presented by Dr. S. A. Mitchell, director of the McCormick Observatory, University of Virginia, who will discuss "Atomic Structure under Conditions of Temperature and Pressure found at the Sun's Surface," and by Dr. J. Q. Stewart, of the Princeton University Observatory, whose subject will be "The General Problems of Astrophysics with Special Reference to the Opacity of Gases."

Among recent developments in physics three topics of widespread interest will be considered in papers entitled: "Secondary Structure of Crystals," by Professor F. Zwicky, of the California Institute of Technology; "Improvements in Technique in the Study of the Raman Effect with Particular Reference to Excitation by Single Lines," by Professor R. W. Wood, of the Johns Hopkins University, and "X-Ray Scattering and Atomic Structure," by Professor Arthur H. Compton, of the University of Chicago.

An address that will be of special interest to scientists in general will be given by Sir William Bragg, director of the Royal Institution of Great Britain, who will speak on "Faraday's Diary."

With a limited formal program, it is hoped that those attending the meeting will have an opportunity, often lacking at more crowded meetings, for getting better acquainted and for leisurely discussion of scientific topics.

On the day before the program begins at Ithaca, those attending the meeting have been invited by the Corning Glass Works to be their guests at a luncheon at Corning, N. Y., and to visit the factories at Corning and at Wellsboro, Pennsylvania.

ESTABLISHMENT OF THE INSTITUTE FOR ADVANCED STUDY

Plans are announced for the establishment and endowment of the "Institute for Advanced Study." The fundamental conception underlying the plans is set forth in a letter addressed by Mr. Louis Bamberger, formerly head of L. Bamberger and Co., of Newark, and his sister, Mrs. Felix Fuld, wife of Mr. Bamberger's late partner, to those who will be trustees of the institute for its first year.

The Institute for Advanced Study will provide facilities with which eminent men of learning may devote themselves to research and the training of advanced students for and beyond the degree of doctor of philosophy or other professional degrees of equal standing. This, therefore, will be exclusively a post-graduate institution.

Mr. Bamberger and Mrs. Fuld propose to provide the institution with an initial endowment of $5,000,000 to which they expect to make further additions to an extent which they hope will provide adequately for the purposes of the institute.

Dr. Abraham Flexner, formerly secretary and director of the Division of medical education of the General Education Board, will serve as the first director of the division of medical education of the the services as members of the faculty and staff of outstanding and most promising teachers in their respective fields.

The institute will be located in Newark or its vicinity. At its inception it will probably occupy temporary quarters while plans for permanent buildings and equipment are being developed, while the faculty and staff are being selected and the organization work of the institute is being effected.

The trustees for the first year are the following:

Dr. Frank Aydelotte, president of Swarthmore College.
Edgar S. Bamberger, of Newark, N. J.
Louis Bamberger, one of the founders.
Dr. Alexis Carrel, member of the Rockefeller Institute.
Dr. Abraham Flexner.
Dr. Julius Friedenwald, of Baltimore, Maryland.
Mrs. Felix Fuld, one of the founders.
John R. Hardin, of Pitney, Hardin and Skinner, Newark.
The Honorable Alanson B. Houghton, formerly U. S. Ambassador to Germany and later to Great Britain.
The Honorable Herbert H. Lehman, Lieutenant-Governor of New York.
Samuel D. Leidesdorf, of S. D. Leidesdorf and Co., New York City.
Herbert H. Maass, attorney-at-law, New York City.
Dr. Florence R. Sabin, member of Rockefeller Institute.
Percy S. Straus, of R. H. Macy and Co.
Dr. Lewis H. Weed, dean of the medical faculty of the Johns Hopkins University.

SCIENTIFIC NOTES AND NEWS

A portrait by Mr. Ralph Clarkson of Professor Eliakim Hastings Moore, head of the department of mathematics in the University of Chicago, given to the university by his former students, colleagues and friends, will be hung in the new Eckhart Hall of Mathematics, Physics and Astronomy.

AT the commencement of the University of California, the honorary degree of doctor of laws was conferred on Florian Cajori, the historian of mathematics, on Harvey Wiley Corbett, the architect, and on Frederick Hanley Seares, the astronomer.

THE University of Oxford will confer on June 23 the honorary doctorate of science on Sir Arthur Keith.

PROFESSOR ALFRED HETTNER, of the University of Heidelberg, is the twenty-seventh recipient of the Cullum Gold Medal of the American Geographical Society, New York City. The medal is awarded from time to time to those "who distinguish themselves by geographical discoveries or in the advancement of geographical science." Presentation of the medal will be made at the University of Heidelberg by Ambassador Sackett, who will represent the society.

DR. CARL E. GUTHE, director of the Museum of Anthropology at the University of Michigan, was awarded the Lapham Medal for distinguished service in anthropological research at a meeting of the central section of the American Anthropological Association held in Milwaukee on May 10.

PROFESSOR M. L. FERNALD, of Harvard University, has been elected a member of the Societas Phytogeographica Suecana. Professor Fernald will spend the summer in England and France, studying types of American plants. In August he will read an invitation paper at the fifth International Botanical Congress at the University of Cambridge.

PRESENT and former students of Dr. Wilder D. Bancroft, professor of physical chemistry at Cornell University, are planning a testimonial dinner in his honor on Saturday, June 21, at Ithaca. This dinner will be given after the close of the Colloid Symposium.

DR. FRANK BILLINGS will be the guest of honor at a banquet to be given by alumni of Rush Medical College at the Statler Hotel in Detroit on Wednesday, June 25, at 7 p. m. Moving pictures of the old Rush Medical College and of the new University of Chicago medical buildings, of the faculty and of the alumni will be shown.

THE board of managers and the medical advisory board of the National Jewish Hospital at Denver gave a dinner on May 27 in honor of the seventy-fifth birthday of Dr. Henry Sewall, professor of medicine emeritus in the University of Colorado.

THE insignia of a knight of the first class of the National Order of St. Olaf has been conferred on Dr. Augustus Trowbridge, dean of the graduate school of Princeton University, by Haakon VII, King of Norway, in recognition of his work in assisting the Norwegian government to obtain funds from international sources for the erection of the Arctic Observatory.

THE president and council of the Royal Society have recommended the Prime Minister, Mr. MacDonald, and General Smuts for election into the society under the special statute which permits the election of "persons who, in their opinion, either have rendered conspicuous service to the cause of science, or are such that their election would be of signal benefit to the society."

THE services which have been rendered to the science of botany by Dr. George Claridge Druce, of Oxford, were honored on May 23, his eightieth birthday, when he was presented by Lord Grey of Fallodon, on behalf of the Botanical Exchange Club and Society of Great Britain, with a check. With this gift Dr. Druce intends to acquire a plot of land, which will be handed over later to the Society for the Preservation of Nature Reserves or to the National Trust for the special purpose of preserving a plant that is now rare in the British Isles. The ceremony of presentation took place at a reception which was given to Dr. Druce in the Great Central Hotel in presence of a large company. Sir Maurice Abbot-Anderson was in the chair. Messages were received from universities and botanical gardens at Paris, Geneva, Copenhagen, Bergen, Brussels, Vienna, Harvard and New York, and from many English societies, including the Royal Horticultural Society and the Gilbert White Fellowship. Dr. Druce was the guest at a luncheon given in his honor by Lord and Lady Buxton at which the speakers included the chancellor of the University of Oxford and Lord Grey.

DR. HOWARD E. SIMPSON, of the State University of North Dakota, was elected to succeed Professor Robert M. Dolve, of the State Agricultural College, as president of the North Dakota Academy of Science at the recent annual meeting held in Fargo. Dr. G. A. Abbott, of the State University, was re-elected secretary, a position in which he has continuously served for several years.

MR. JAMES D. SISLER, associate state geologist of Pennsylvania, has been elected state geologist of West Virginia, and will assume his work at Morgantown, West Virginia, on July 1.

DR. HELEN THOMPSON WOOLLEY, professor of education and director of the Child Development Institute of Teachers College, Columbia University, has presented her resignation to take effect on September 1.

AT Yale University, Dr. Mark A. May has been appointed director of the statistical bureau of the

Institute of Human Relations. Professor Walter R. Miles and Dr. Catherine Cox Miles, of Stanford University, have been appointed research associates in psychiatry and psychology. Both have been assigned to the Graduate School, the School of Medicine and the Institute of Human Relations.

DR. SAMUEL T. ORTON has been appointed professor of neurology and neuropathology at the College of Physicians and Surgeons of Columbia University and Dr. Henry A. Riley has been appointed professor of neurology and neuro-anatomy.

DR. DAVID MCCLELLAN DE FOREST, assistant professor of zoology at the University of Tennessee, has been appointed to the faculty of the American University at Beirut, Syria, as adjunct professor in zoology, for the academic year 1930–31.

DR. W. T. THOM, JR., of Princeton University, has resigned from the U. S. Geological Survey, and will divide the summer between university research and field studies contributing to a research project sponsored by the American Association of Petroleum Geologists. This latter project deals with the regional structure of the Dakota sandstone in the Northern Great Plains and Foothills regions, and is being pursued because of the light it may shed upon the causes and results of mountain building.

MR. J. M. F. DRUMMOND, regius professor of botany in the University of Glasgow, has accepted an offer of appointment as Harrison professor of botany and director of the botanical laboratories in the University of Manchester.

MR. J. S. L. GILMOUR, of Clare College, has been appointed curator of the herbarium and botanical museum of the University of Cambridge for five years.

M. G. FAYET, director of the observatory at Nice, has been appointed *membre titulaire* of the Bureau des Longitudes in succession to the late M. Andoyer.

PROFESSOR KARL JOHANN FREUDENBERG, of the University of Heidelberg, has been appointed Carl Schurz Memorial Professor at the University of Wisconsin for the second semester of the coming school year, beginning on February 9, 1931. Professor Freudenberg's chief researches have been along the lines of the chemistry of the tannins; lignins and cellulose; sugars; insulin, and stereochemistry. He will give two series of lectures on selected topics in advanced organic chemistry and will take a few well advanced students for research. Such students should have had previous experience in research in organic chemistry. Applications for permission to do such work should be addressed to Professor J. H. Mathews, chairman of the department of chemistry. The lectures will be open to students who have had a full year's course in organic chemistry.

DR. WILLIAM MORRIS DAVIS, professor emeritus of physiography at Harvard University, is leaving Tucson, Arizona, and will spend the summer at the University of Oregon.

DR. A. C. LAWSON, professor of mineralogy and geology and dean of the college of mining at the University of California, has gone to Europe to attend the Walther celebration and in the interest of the program of the International Geological Congress in 1932. He is chairman of the program committee.

DR. ARTHUR KEITH, chairman of the division of geology and geography of the National Research Council, has sailed for Europe to attend the centennial of the French Geological Society.

DR. WILFRED H. OSGOOD, curator of zoology at Field Museum of Natural History, has returned from London where he has been engaged in research at the British Museum in connection with specimens of rare animals obtained by the recent William V. Kelley-Roosevelts Expedition to Eastern Asia for Field Museum.

DR. F. M. HAYES, professor of veterinary science in the University of California, will spend several months in Europe, with the object of studying, chiefly at the University of Giessen, bovine tuberculosis and Bangs disease. Dr. Hayes will attend the International Veterinary Congress in London during August, and later hopes to be present at the International Institute of Tuberculosis in Oslo, Norway.

PROFESSOR HOMER W. SMITH, of University and Bellevue Medical College, is on leave of absence as Fellow of the John Simon Guggenheim Memorial Foundation to visit Siam, Sumatra and Borneo, where he plans to study kidney function, the composition of the body fluids and allied biochemical problems in fresh-water elasmobranchs and terrestrial fishes.

DR. HANS BECKER, lecturer in geology in the University of Leipzig, is working at the University of Wisconsin on sedimentation under Professor W. H. Twenhofel, of the department of geology.

DR. JOHN C. MERRIAM, president of the Carnegie Institution, gave the commencement address at New York University on June 11.

AT the convocation exercises of the graduate school of Brown University on June 14, Dr. Edwin Grant Conklin, of Princeton University, Henry Fairfield Osborn professor of biology at Princeton University, will be the speaker. The title of his address will be "Science and the Future of Man."

Professor F. K. Richtmyer, of Cornell University, gave the address at the initiation meeting of the Society of Sigma Xi at Ohio State University on May 15. He also spoke before the physics seminar on "Secondary X-ray Spectra."

Professor Carl J. Drake, of the Iowa State College, Ames, lectured on "The European Corn Borer" in Davenport on May 16, the lecture being given by the Davenport Public Museum with the cooperation of the agricultural agents of ten surrounding counties in Iowa and Illinois.

Dr. W. E. Castle, of the Bussey Institution, Harvard University, gave an address on May 21 on "The Significance of Sexuality in Organisms" before the Brown University Chapter of Sigma Xi at Providence.

Dr. A. C. Lane, Pearson professor of geology and mineralogy, emeritus, at Tufts College, spoke on "The Age of the Earth" through the National Broadcasting Unit at 245 E Street, Washington, D. C., for Science Service on June 6. He has been consultant in science for the Library of Congress for this semester.

Donations from the Rockefeller Foundation totaling $887,500 to Johns Hopkins University for the increased support of the biological sciences, and $100,000 for "a fluid research in the humanities," have been announced by President Joseph S. Ames. For the biological sciences $387,500 will be given over a period of ten years and $500,000 at the end of this period. The money for research in the humanities is to be given over a period of five years. The work in biology to be supported is being done by the following: Dr. Raymond Pearl, who has been director of the Institute of Biology, which has been financed over a five-year period ending this year. He will become professor of biology in the School of Hygiene and Public Health at the beginning of the next scholastic year. Dr. H. S. Jennings, Henry Walters professor of zoology and director of the laboratory; Dr. Duncan S. Johnson, professor of botany and director of the laboratory, and Dr. Burton E. Livingston, professor of plant physiology and director of the laboratory.

Mr. John D. Rockefeller, Jr., has offered to the city of New York a sixty-acre tract in Washington Heights, in northern Manhattan, for a public park, and has offered to spend about $5,000,000 to make the tract, valued at $7,000,000, suitable for public purposes. Mr. Rockefeller tendered the $12,000,000 gift in a letter to Mayor Walker, who characterized it as "a very gracious offer."

Mr. John D. Rockefeller, Jr., has contributed $200,000 toward the cost of a building for botany at the Botanical Gardens and Natural History Museum, Paris, where it is planned to establish an International Botanical Institute. The French Government has also promised to contribute $200,000 and subscriptions are being sought to the amount of $320,000.

Yale University will eventually inherit more than $200,000 of the estate of Edward Anthony Bradford, editorial writer of *The New York Times,* who died in 1928.

From the profits from the sale of German dyes turned over to the United States by the Reparations Committee in 1920, Princeton University, Massachusetts Institute of Technology and the Philadelphia Textile School have received a total amount of over $400,000 to be used for scientific research divided as follows: Princeton University, $124,233; Massachusetts Institute of Technology, $28,057, and the Philadelphia Textile School, $248,507.

Forty-three engineers and industrial executives, headed by Professor Robert Sibley, of the department of mechanical engineering of the University of California, sailed on June 3 to attend the second International Power Conference in Berlin to be held from June 16 to 25. The conference, which has been called by the German Government, will be attended by representatives of forty-seven nations. It is the outgrowth of a similar meeting held in London six years ago. A special effort is to be made at this year's conference to start a movement to regulate and standardize legal problems arising from international use of power resources.

On May 9 and 10 the Nebraska Academy of Sciences held its fortieth annual meeting at Peru, Nebraska, State Teachers College, jointly with the Nebraska section of the Mathematics Association of America and the Nebraska Council of Geography Teachers. Lectures on the general program of the academy included: "Fossil Flora and Fauna of Nebraska," by Dr. E. H. Barbour, of the University of Nebraska; "The Use of Physical and Physico-Chemical Measurements in the Sciences," by Dr. F. E. E. Germann, of the University of Colorado; "Our Solar System and how we got it," by Dr. D. W. Morehouse, president of Drake University, and "Biological Aspects of Rocky Mountain National Park," by Dr. R. J. Pool, of the University of Nebraska. The outgoing president of the Nebraska Academy is Dr. A. E. Holch, professor of botany in the Nebraska State Teachers College, Peru. The newly elected officers are Dr. H. H. Marvin, of the University of Nebraska, *president;* Dr. H. von W. Schulte, of Omaha, *vice-president;* Professor M. P. Brunig, of the University of Nebraska, *secretary,* and Professor P. K. Slaymaker, of the University of Nebraska, *treasurer.* The meeting of the Nebraska Academy in 1931 will be held in Lincoln and the 1932 meeting in Omaha.

THE New York State Geological Association held its sixth annual field meet at Union College, Schenectady, N. Y., on May 16 and 17, under the presidency of Professor Edward S. C. Smith. The first day was spent north of Schenectady near Saratoga and Schuylerville. The Precambrian, Cambrian and Ordovician rocks were studied. The Cryptozoon ledge, diabase dike cutting Grenville sediments, the overthrust at Bald Mountain and Stark's knob at Schuylerville were of special interest. That evening at the Mohawk Golf Club, President Day and Professor Emeritus Stoller, of Union College, addressed the geologists. Professor Stoller spoke of the Pleistocene and Post-Pleistocene drainage changes in the immediate region. On Saturday, the Helderberg escarpment and the Schoharie district were visited, a region of particular interest to paleontologists. Fossils were collected from the Devonian and Silurian outcrops. In the evening the members of the New York State Museum were hosts to the geologists in the museum in Albany. Two hundred students and their instructors, representing twenty-four educational institutions, attended the field meet. Next year the association plans to meet in the Mineville-Port Henry district of the Eastern Adirondacks. Professor Harry N. Eaton, of Elmira College, was elected president, and Professor O. D. von Engeln, of Cornell University, secretary.

THE annual field excursion of the section of geology of the Ohio Academy of Science was conducted in eastern Ohio on May 30, 31 and June 1. Special attention was given to the physiographic features of Guernsey, Belmont, Monroe and Noble Counties. Studies were also made of the stratigraphy of the Pennsylvanian and Permian systems, and the structure of the Cambridge anticline and the Parkersburg-Lorraine syncline. Fifty-seven people participated in the excursion, which was conducted by Wilber Stout, state geologist, and Paris B. Stockdale, vice-president of the section of geology of the Ohio Academy of Science.

DISCUSSION

RACE MIXTURE AND PHYSICAL DISHARMONIES

PROFESSOR H. S. JENNINGS in his recent book on "The Biological Basis of Human Nature" devotes a chapter to the subject of race mixture and its consequences. Considering first the purely physical results, he mentions both advantages and disadvantages resulting from wide racial crosses. As an advantage he reckons hybrid vigor and the covering up in the immediate offspring of any recessive defects which may be present in either parent race. As a disadvantage he mentions possible disharmony in details of structure. It is to this latter point that I wish to give brief consideration, as it is a matter of considerable biological importance apart from its human interest.

Jennings says, on page 280:

> Working probably to the disadvantage of some race mixtures in man is the fact that certain human races differ in such ways that union of their characteristics may yield combinations that are in details inharmonious. In the mixture of races found in the United States, as Davenport[1] has pointed out, some of the stocks differ greatly in physique from others. Some are smaller, having organs that go with a small body—small heart, small kidneys, small jaws, small teeth; such on the whole are the races that come from the Mediterranean region of Europe. Others have large bodies, with large kidneys, heart, jaws, teeth, and other organs.
>
> Judging from what occurs in other organisms, when such diverse races are crossed, the offspring, receiving genes from both sides, may well develop combinations of parts that lack complete harmony. If a large body is combined with small kidneys, the latter may be insufficient for the needs of the individual. Or a large body might be combined with a small heart that would not keep the blood properly circulated. Large teeth, resulting from the genes of one parent, may be crowded in a small jaw that results from the genes of the other parent. In consequence the teeth decay. Partly to it, Davenport (by whom the examples given above are suggested) ascribes the prevalence of defective teeth in the United States. According to him, crowded and defective teeth are less common in nations with races less mixed.
>
> It is difficult to measure with certainty lack of harmony between body size and size of kidney or heart, so that direct proof that the possible inharmonious combinations mentioned above actually occur in man as a result of mixture of races is not available. But the occurrence of inharmonious combinations of certain bodily parts as a result of race crossing has been observed both in man and in other organisms. A striking case of this kind in the dog—comic rather than tragic in its consequences—is described by Lang.[2] A great St. Bernard dog was crossed with a dachshund. Some of the progeny had the large heavy body of the St. Bernard, resting on the short crooked legs of the dachshund. The result (figure 49) was neither beautiful nor efficient.
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> The occurrence of inharmonious combinations, in human race crosses, has been shown with respect to parts of the body that are measurable, in the recent study

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[1] C. B. Davenport, "The Effects of Race Intermingling," *Proc. Am. Phil. Soc.*, 56: 364–368, 1917.

[2] A. Lang, "Experimentelle Vererbungslehre," Vol. I, p. 727, 1914.

made by Davenport and Steggerda[3] on the whites and blacks in Jamaica, and on the browns resulting from crosses between them. The whites have relatively short legs and long bodies, while the blacks have relatively long legs and short bodies. "Some of the mulattoes have an unexpected combination of long legs and long body and others of short legs and short body" (Davenport). Again, in the blacks, arms and legs are both long; in the whites, both are shorter. Some of the crosses have "the long legs of the Negro and the short arms of the white which would put them at a disadvantage in picking up things from the ground."

Since inharmonious combinations of physical characteristics that are thus open to precise study are shown to occur as a result of race crossing, it appears probable that similarly inharmonious combinations of a more serious character may likewise occur, giving rise to insufficiency of heart or kidneys, or to crowding of teeth, as suggested in a former paragraph.

(1) As to the large-sized dog with short crooked legs and of St. Bernard-dachshund ancestry, what is the evidence that its lack of beauty and efficiency is a consequence of race mixture? Is not the dachshund equally lacking in beauty and efficiency? The crossbred has inherited the same dominant achondroplastic gene which is possessed by all dachshunds. There is no more disharmony in the progeny than in the dachshund ancestors. The dachshund breed is itself a race of hereditary defectives.

Suppose that a white man who was affected with Huntington's chorea should marry a Negro woman and half their children should prove to be choreic (as in all probability they would), could we ascribe this unfortunate occurrence to race mixture? By no means, the same result would have followed had the wife been a white woman.

(2) As to the supposed occurrence of disproportionally small kidneys and hearts in crosses between races of southern and northern Europe, there is more than room for doubt; there is a complete *vacuum* of evidence. I would invite any anatomist who has studied the size and efficiency of human kidneys and hearts to produce evidence that the size of these organs in relation to general body size is more variable in crossbreds or less closely correlated with general size than in either pure Nordics or pure Mediterraneans (if he can find such). The fallacy involved in this case is one which Jennings in other parts of his book has pointed out, that of supposing the anatomical parts of the body to be unit-characters and so independent of each other in their inheritance. In his zeal to avoid the fallacy Jennings condemns the term unit-character altogether, yet is himself guilty of endorsing the idea that a small kidney or small heart as such might be inherited from a small ancestor, and a large body to contain them from a large ancestor. Any one who has studied size inheritance in a mammal would know that nothing of the sort can be detected in size crosses much more extreme than any possible in the human species. For example, in rabbits races have been crossed, one of which had four times the average weight of the other. Each of these races was quite uniform in weight, more so probably than any human race. The crossbreds were with equal uniformity of an intermediate size, and in the second crossbred generation (F_2) no excessive variability was found or the slightest evidence of disharmonies, though an express search was made for them in a careful study of the correlation between skeletal parts among themselves and in relation to total body weight. It was found that when, by crossbreeding, races of intermediate size are produced, all parts of the skeleton are also intermediate and suited to each other, all being developed under a common influence, the fundamental rate of growth, which is the master controller of all general ontogenetic processes from early cleavage stages on.[4]

(3) As to the reputed occurrence of inharmonious combinations between parts of the body that are measurable, in the recent study made by Davenport and Steggerda of whites, blacks and browns in Jamaica, let us appeal from the generalizations to the detailed evidence presented by these authors in their final report. In over a hundred photographs of individuals in varied attire we look in vain for indications of one having "the long legs of the Negro and the short arms of the white, which would put them at a disadvantage in picking up things from the ground." I should greatly like to see such a picture or any other sort of evidence that a mulatto was at a physical disadvantage in picking up things because his arms were too short and his legs too long. Yet Davenport and Steggerda say in their summary of conclusions (p. 473) "The leg of the blacks is much longer than that of the whites." Turning to the detailed measurements on which this conclusion is ostensibly based (p. 119), we find the following statistics concerning leg length (in cm) in adult male blacks, browns and whites.

	Blacks (53)	Browns (91)	Whites (48)
Mean and P. E.	92.5 ± 0.4	92.3 ± .03	92.0 ± 0.4
σ and P. E.	4.8 ± 0.3	4.8 ± 0.2	4.2 ± 0.3
C. V.	5.2 p. c.	5.2 p. c.	4.6 p. c.

The reputed "much longer" leg length of the blacks turns out to be on the average longer by five tenths of a centimeter! The leg length of browns is strictly intermediate between that of blacks and whites and not more variable, since the standard deviation (σ) and coefficient of variability (C. V.) are exactly the same for blacks as for browns. Surely a leg longer by three tenths of a centimeter would not be a serious physical handicap to a brown in competition with a white. Actually we look in vain for the extra-long-legged brown. No single brown has longer legs than the longest-legged whites, and two browns have shorter legs than any white.

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[3] C. B. Davenport and M. Steggerda, "Race Crossing in Jamaica," Pub. No. 395, Carnegie Institution of Washington, 516 pp., 1929.

[4] Castle, *Jour. Exp. Zool.*, 1929.

But perhaps it is leg length in relation to total stature that puts browns at a physical disadvantage in relation to whites and blacks. Let us see. On page 45 we find the following data on total height of adult males of the three groups.

	Blacks (54)	Browns (93)	Whites (50)
Mean and P. E.	170.6 ± 0.6	170.2 ± 0.5	172.7 ± 0.7
σ and P. E.	6.8 ± 0.4	6.7 ± 0.3	6.9 ± 0.5
C. V.	3.96 p. c.	3.97 p. c.	3.97 p. c.

On the average whites are two centimeters taller than blacks and browns, but the variability of all three groups is substantially the same, although that of browns is the lowest, notwithstanding the fact that it is the most numerous group, and if recombination occurs in browns of genes for tallness and shortness obtained from whites and blacks respectively, we should expect browns to be most variable. Accordingly, I am at a loss to see where either Davenport or Jennings finds justification for the idea that the brown Jamaicans have dangerously disharmonious combinations of stature and leg-length.

But according to the quotation, it is the short arms inherited by the browns from the whites which, combined with the supposed long legs derived from the blacks, put them at a disadvantage. Let us see how great the difference in arm length is. On page 88 (Davenport and Steggerda) the following statistics are given for arm length (acromion-stylion) of adult males.

	Blacks	Browns	Whites
Mean and P. E.	57.3 ± 0.3	57.9 ± 0.2	56.8 ± 0.3
σ and P. E.	3.1 ± 0.2	3.1 ± 0.1	2.9 ± 0.2
C. V.	5.5 p. c.	5.4 p. c.	5.2 p. c.

The difference in mean arm length between blacks and whites is five tenths of a centimeter, exactly the same as in mean leg length. In other words, there is evidently a very close correlation in man as in rabbits between arm length and leg length. The blacks have longer arms as well as longer legs than the whites, but the difference is very small, five tenths of a centimeter.

Now let us suppose that the worst fears of Davenport and Jennings were realized and a brown inherited "the long legs of the Negro and the short arms of the white, which would put them [him] at a disadvantage in picking things up from the ground," how much farther would he have to stoop in order to reach the ground with his finger tips? *Just one centimeter!* I do not think that an employer would find a brown so constituted at a serious disadvantage as a field hand in comparison with either blacks or whites. As a matter of fact, I very much question the independent inheritance of leg length and arm length in man. I think if the matter were studied from the records of Davenport and Steggerda (which they do not publish in a form available for this purpose) it would be found in man, as I have found in rabbits, that a close correlation exists between the dimensions of upper and lower extremities. The coefficient of correlation in rabbits was found to be for femur-humerus, 0.91; for tibia-humerus, 0.90; for femur-tibia, 0.93 (Castle, 1922).

If there were unit-character inheritance of the difference in arm length and leg length between blacks and whites, then we should expect to find browns more variable than either blacks or whites through recombination of units. This they are emphatically not, according to the statistics of Davenport and Steggerda. Hence we may dismiss as wholly unsupported by evidence as yet produced the idea that a brown *could* inherit "the long legs of the Negro and the short arms of the white." Even if he did, it would be a matter of no consequence, as Jennings would doubtless admit. He cites it merely as an indication that "similarly inharmonious combinations of a more serious character may likewise occur, giving rise to insufficiency of heart or kidneys." Since the evidence of the assumed independent inheritance of arm and leg length is wholly lacking, the case is valueless to support an apprehension itself without other support and almost incapable of verification.

We like to think of the Negro as an inferior. We like to think of Negro-white crosses as a degradation of the white race. We look for evidence in support of the idea and try to persuade ourselves that we have found it even when the resemblance is very slight. The honestly made records of Davenport and Steggerda tell a very different story about hybrid Jamaicans from that which Davenport and Jennings tell about them in broad sweeping statements. The former will never reach the ears of eugenics propagandists and Congressional committees; the latter will be with us as the bogey men of pure-race enthusiasts for the next hundred years.

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THE PLANT QUARANTINES ONCE MORE

The article by Professor E. O. Essig in a recent number of Science[1] presents a fair statement of the point of view of those who support the program of federal and state plant quarantines which has reached its most conspicuous phase in connection with the invasion of Florida by the Mediterranean fruit-fly. And as such a statement it reveals clearly the weaknesses in the arguments of the supporters of these measures. The most pronounced of those weaknesses is the refusal of these supporters to face squarely certain disagreeable facts.

Professor Essig sums up the value of the fruit industry in the area where the fruit-fly might live and contrasts its annual crop value of an estimated $240,000,000 with the paltry sums aggregating—according to his figures—$5,250,000, which have been expended by governmental agencies in the war against the Mediterranean fruit-fly in Florida. There is in his article no intimation that this is not a full and adequate statement of the case. Nor is there any recognition of the fact that a proper accounting will charge against the quarantines and their associated measures not merely the sums of money expended by government officials in their administration but all other sums for which the quarantines are responsible.

The actual damage done by the fruit-fly in Florida through the spoiling of fruit and rendering it inedible was relatively insignificant. It was so small that it had not impressed itself upon the consciousness of the growers. But the application of the quarantines, with their restrictions upon marketing of fruit and vegetables, brought about bank losses which have been estimated at $60,000,000. I know of no estimates of the losses suffered by growers and not included in the bank losses, but surely an estimate of $5,000,000 would not be too high. We have then, instead of about $5,000,000, at least $70,000,000 to be charged up as the cost of the "protective" measures which were undertaken. This is an amount equal to more than one fourth of the annual value of the crop which is being protected. Furthermore, it should be noted that only a part of this fruit crop is subject to infestation by the fly, for the evidence indicates clearly that many fruits will not be attacked in any significant degree. It would probably be closer to the facts to estimate that the actual costs in Florida for the first year of the campaign against the fly which are to be charged up to the restrictive and control measures alone and not to the damage done by the insect are equal—on the basis of the figures given by Professor Essig—to at least one half the value of the fruit crop for one year in the area subject to infestation. And at the present writing the fly is not yet eradicated.

The ignoring of such facts as this is accompanied by an equally obtuse refusal to face certain other facts. The monetary losses of the fruit-fly campaign have been accompanied by the development of sectional bitterness that it will take long to remove and that is perhaps as important as are the financial aspects. Such effects can not be set aside as unimportant. The effect of the quarantine measures in stirring up intersectional and interstate resentments and competition outside of the normal and legitimate range of commercial rivalry is a dangerous aspect of their results. They set up what are in effect prohibitive tariff walls among the states, walls which under our national organization are not supposed to exist. They function also as prohibitive international tariffs to which consumers have every right to object.

No reference to such effects is to be found in the rosy picture of the plant quarantines which is presented by Professor Essig. Nor is any reference there to be found to the absurdities of quarantines directed against wind-borne insects, to the absurdities of intercounty quarantines, to the inadequacy of training of personnel, to the gaps that are left open by quarantine administrators, to the cost of a service to which adequate salaries would attract adequately trained men and which would permit the actual achievement of the functions for which the quarantines are presumably established. These are things which the supporters of the quarantines may discuss in private, but in public never.

That the effectiveness of the quarantines has in some cases been greatly overrated is indicated by the following example. In the mimeographed copy of a speech delivered in December, 1929, by Mr. G. H. Hecke, state director of agriculture of California, there is contained the following statement:

> For eight years the alfalfa weevil has been halted at the California line, although it jumped from the Salt Lake Valley in Utah into the Reno-Sparks district of Nevada in twenty-four months. Unrelenting quarantine vigilance has kept it from the major alfalfa-producing districts of this state.

I have available an authoritative statement of the actual facts concerning the spread of the alfalfa weevil. According to this statement the weevil was present in Salt Lake County, Utah, before 1905. It appeared in Washoe County, Nevada—which is the

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[1] Science, N. S. 71: 350–353, April 4, 1930.

Reno-Sparks district—in 1920, its establishment in this county being of probably not more than a year's duration. This is an interval of at least fifteen years, instead of the two years indicated in the statement quoted. It was first found in Sierra County, California, in 1923 and in Plumas and Lassen Counties in 1925. A reference to the map of California will indicate that the insect was halted, not at the state line by the vigilance of the quarantine officials, but at the line of the Sierras in all probability by the natural barrier of the mountains.

That the plant quarantines have certain possible protective values may freely be admitted. Just how far those values extend and how to obtain them and still avoid the dangers that have been pointed out, how to obtain them at a price that has a proper relation to that which is bought, how to serve one portion of the population without infringing upon the equally just rights of another part—these are serious problems. That they can be solved and the quarantines maintained is debatable. The arguments against the quarantines are real; the solution is not to be obtained by ignoring them. It would seem desirable for the supporters of these measures to enlarge the range of their view sufficiently to include a larger proportion of the facts of the situation.

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HAIR GROWTH AND PREGNANCY

IN studying the rate of hair growth on guinea-pigs by the method of observing the regeneration of hair on shaved areas, it was noted that in pregnant females the number of hairs which regenerate reaches a minimum at the time of delivery. This observation is of special interest since the literature records conflicting observations on hair growth during pregnancy in women; references concerning increased hair growth during this period are quite as numerous as references to a retardation of hair growth or quiescence of the follicles.

In order to test the constancy of this phenomenon, the backs of a series of guinea-pigs were shaved weekly and observed over a period of six months. The amount of regeneration was computed by counting the number of follicles in the shaved area (a two centimeter square) and noting those which were active and those which were in a resting stage. This series of animals was composed of five unmated males, five virgin females, two breeding males and ten breeding females. In view of the possibility that the condition observed might be due to the cyclic or seasonal activity of the follicle, the males and the virgin females were used to control such possible factors.

The regeneration of the hair in the shaved areas in all control animals was uniform (approximately 25 per cent. of the follicles being in an active state), whereas in all pregnant females the number of hairs regenerating was noticeably less by about the third week before delivery and continued to decrease until delivery, at which time the minimum regeneration was noted (less than 1 per cent.). After delivery the follicles remained in a quiescent state for approximately two weeks. During the third week postpartum the number of regenerating hairs slowly increased and by the end of the fourth week the rate of regeneration had apparently returned to normal.

In some of the pregnant females the hair came out in quantities, leaving areas in the region of the back and sides practically devoid of hairs. This condition occurred in varying degrees.

These observations on the guinea-pig seem to indicate that there may be a negative correlation between the regeneration of hair and pregnancy. At the present time a larger series of guinea-pigs is being observed and full details of the results of experiments now in progress will be published.

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SYMBIOTIC MITES USED TO SEPARATE SPECIES OF A GENUS OF BEES

IN recent years it has been recognized that the parasites found on various species of a group of animals may be able to throw light on problems of taxonomy and general geographical distribution. What is proving to be a very interesting correlation of host and symbiont is being worked out for a group of mites of genus *Dinogamasus* and their hosts, certain carpenter-bees at present considered as members of genus *Mesotrichia* Westwood. These carpenter-bees are mainly confined to the Ethiopian and Oriental regions and one species occurs from Egypt to the northwest provinces of India.

In the first abdominal segment of the female bees there is a peculiar chamber formed by an inflated invagination of the chitinous exoskeleton. Within this pouch, or chamber, which has no opening into the body of the bee, a few or a dozen or more of the little mites may be found.

The mites which I have collected from the African bees fall into three distinct groups and their hosts seem to belong to corresponding groups. The mites examined from the Oriental regions also seem to belong to a few distinct groups all readily distinguishable from the African forms. Usually each species of bee has its own characteristic mite regardless of a wide geographic range. In some cases very closely allied bees have the same kind of mite.

A very fine example of the value of knowing the correlation of host and symbiont was demonstrated when studying the disputed *Mesotrichia aestuans* and *M. confusa* of India. *M. aestuans* is a recognized north African form, and within its pouch there is a characteristic African mite belonging to the *braunsi* group which I have named *Dinogamasus inflatus* because of certain swollen hairs on the legs. There has been more or less uncertainty whether the *confusa* of the Orient is the same as the African *aestuans*. Pérez recognized the two forms, using the margin of the clypeus, the clypeal keel and the frontal keel as the main distinguishing features. It has been recently claimed that these species are not distinct.

It was interesting to find that two specimens of these disputed bees which I had from northern India had the African *Dinogamasus inflatus* in the pouch, and that another bee labeled from Sikkim, India (from the Bingham collection, Berlin Museum), as well as other specimens of *confusa* from other Oriental localities, had mites belonging to the Oriental group.

Dr. T. D. A. Cockerell examined the hosts and upon comparison with an African *aestuans*, taken at Suez, he found that the specimens from northern India (Chikar Kot, N. W. Prov., and Jammu, Kashmir; Frank Benton collector, National Museum specimens) are the genuine *aestuans*, thus evidently belonging to the Palearctic fauna which extends over from northern Africa. The other form of carpenter-bee he determined as the true *confusa*, and this, belonging to the Oriental region, naturally should harbor a distinctly Oriental species of mite.

Another case of the mites helping to distinguish between slightly differing hosts may be cited. Two specimens labeled *confusa*, one from Singapore and one from Trang, Siam, yielded closely related but nevertheless distinctly different species of mites. Examination of the hosts showed that the one from Trang was *M. confusa* var. *viridissima*. It is conceded now that this form should be considered a valid species *M. viridissima*.

NORMA LEVEQUE

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PROFESSOR EINSTEIN'S ADDRESS AT THE UNIVERSITY OF NOTTINGHAM[1]

PROFESSOR EINSTEIN does not wish you to accept his remarks on credit, but wishes to explain in the clearest way possible what he considers to be the trend of modern physics. What he has to say is his purely subjective opinion and it is by no means generally recognized. He thinks that he can give you at least some outline of what his view is of the future of the subject, but he does not want his remarks to be regarded as assertions. He wants them to be regarded rather as humble expressions of his opinion.

He will now concentrate our attention on the fundamental conceptions which lay at the beginnings of the foundations of physics. Professor Einstein makes clear what the prescientific view was and explains that the primitive concept was that of a rigid body and that relationships in the positions of rigid bodies preceded all ideas of space; that space was not a primary conception and that it was only through dealing with the position and relationships of bodies that the idea of space later emerged.

These ideas of space were due, of course, to contact relationships between bodies, and it is interesting to know that the classical science of the Greeks did not operate with space but exclusively with bodies. A rigid body is at the bottom of all the conceptions of geometrical space in Euclid.

The idea of a space continuum entered into science only when analytical geometry was invented by Descartes. How did the idea of space originally arise? The Greeks approached position in geometry by considering the position of bodies with regard to each other. This, of course, suggests a body of reference. We are familiar with coordinate systems in geography in the way in which they were used, for instance, in maps of geography.

Space appears expressed in body-like form by means of these axes of reference. This is really the way in which space as such entered into geography in the first place, and there was no physical basis for it. Relative motion occurs only with reference to one or more bodies. The great change took place in that view when Newton propounded his mechanics.

The fundamental idea of Newton's mechanics was the introduction of the idea of force—that is to say, acceleration. Acceleration can be imagined only in reference to a really rigid body. It is a wonderful tribute to Newton's genius that he could go so far as to give space a definite physical reality.

He included it among the other realities. This is an aspect of his theory which has not been understood or has been neglected or misunderstood by some of his followers. Professor Einstein is very anxious that this particular point be emphasized—that space entered as a definite physical reality. It was a point which was missed even by the philosopher Kant.

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[1] The address given in German on June 7 was translated by Dr. I. H. Brose. A stenographic report of Dr. Brose's translation was cabled to *The New York Times* and permission has been given for publication in SCIENCE.

A remark should be added about the physical idea of space. There are two aspects. In one of them space is to be regarded as the quintessence of positional possibilities of bodies, and, secondly, as a definite dynamic system of reference.

Professor Einstein emphasizes that Newton's space is to be regarded as absolute in the sense that positional possibilities of rigid bodies are to be considered as quite independent of outside forces, although he does not take temperature into consideration. This space is independent of all physical causes and is something which is absolute in itself.

In Professor Einstein's opinion a definite change in the view of nature after the time of Newton occurred when the idea of the electro-magnetic field was introduced by Faraday and Maxwell. The only real things at that time were bodies, space and time. Those were constructive elements from the physical viewpoint of the times. There were no others.

Faraday introduced the idea of "a field," and his contemporaries were bound to that method of introducing the idea of a state owing to the manner of thought of their time.

They, therefore, introduced a new body called the ether—or at least a new idea which they called ether —to represent a physical state. The introduction of ether was necessary in order to allow electro-magnetic phenomena to occur in space. This view received considerable strengthening at the hands of a Dutchman named Lorentz, who showed that in the electro-magnetic theory of states all ponderable bodies were those of ether and not of material bodies themselves.

Looking back now we might ask why ether as such was introduced. Why not have called it "state of ether or state of space"? The reason was they had not yet got to realize the connection or lack of connection between geometry and space, and so they felt constrained to add to space a variable brother, as it were, which could be a carrier for all electromagnetic phenomena.

The next change in the idea of space was comparatively small. It was due to a special theory of relativity sometimes called the "restrictive" theory of relativity. Classical physicists had two separate continua which were to be regarded as a performing stage for continua. Those were space and time. Altogether, they formed four dimensional continua, three being in space and one in time.

But it had to be subdivided into two blocks due to the fact that there were a before and an after and to satisfy the requirements of simultaneity. It was found, however, that to satisfy the demands of the constancy of propagation of light the subdimensions of space and time could not in this way be preserved or carried out.

The space-time phenomenon of the special theory of relativity was something absolute in itself, inasmuch as it was independent of the particular state of motions considered in that theory.

A definite change in our ideas about the rôle and constitution of space was due to the enunciation of the general theory of relativity, for which the ground had been prepared by the special theory of relativity. The law of inertia—we called it Newton's first law of motion—has shown a gap in its logic because we were not able to tell when coordinate systems were in acceleration or in rotation. We had no definite means of establishing it.

This is what is known in the general theory of relativity as "the principle of equivalents." It implies that an accelerated, coordinate system can be regarded in a certain sense as equivalent to what was known as the "inertial system." Watches and measuring rods were not found to operate in the same way for accelerated systems as for coordinate systems of the special theory of relativity.

To preserve the theory of relativity for the accelerated motions as well as for the uniform regular motions of the special theory of relativity, Euclidian geometry, having been found to be too restrictive, had to be rejected and a new geometry of space found. In order to preserve position possibilities of space we were compelled to regard them as no longer independent of positions of other bodies.

In other words, the privileged position of geometry had to be given up and the viewpoint of covariants, as it is known to mathematicians, has been gained. This means that for a description of physical phenomena we must regard all generalized coordinates as of equal validity.

What, as general theory, has relativity then actually achieved? Professor Einstein does not want to enter into the question of the three experimental tests, which have all conformed to his suspicions, but the main achievement of the general theory of relativity is that it has advanced a uniformity of view of the physical world structure. The metrics of space can be derived directly from the full equation and it reduces a number of hypotheses which were originally thought necessary to account for physical phenomena. It has built, so to speak, a bridge between geometry and physics.

The next question is—What are the weaknesses of the general theory of relativity? Taking as a basis the Rummbey-Riff structure of space, we find that geometry and gravitation were completely represented by this structure, but what was to be done with the electro-magnetic phenomena which play an exceedingly important part in the world of physics?

In order to introduce these phenomena and to take them up in the general scheme of relativity it was found necessary to add to or impose upon the metric structure or Rummbey-Riff structure further terms which could account for electro-magnetic phenomena. Logically this structure had nothing to do with that which had been deduced from the elementary law of propagation of light. This duality in the geometrical structure of space leaves us in a rather indistinct state.

Professor Einstein feels that it should be possible to get a further form of this metrical space which will at one stroke comprise all phenomena in one set of equations, so that we shall not have a double metric structure of geometry and gravitation, on the one hand, and electro-magnetics on the other.

We want a system of equations which will take in all physical phenomena. This would be an enormous gain in the picture of the uniformity of physical nature.

As to the way in which the problem may be solved Professor Einstein says that it is a very difficult question to answer, and it has not yet been finished. His colleagues regard his view as a particular craze and do not support it. Nevertheless, he has faith in the path along which he is proceeding, and although the theory is not yet quite finished, he has evidence that so far as he can judge the end is very near.

He says that there is a metrical structure of space, but that a full-time structure has yet to be determined. Then he wishes to find what conditions have to be made in the older structure or what modifications in electro-magnetic phenomena may be included. He emphasizes that he is in no way taking notice of the results of quantum calculation because he believes that by dealing with microscopic phenomena these will come out quite by themselves. Otherwise he would not support the theory.

Then he says that a new idea which has occurred to him and on which he has been working is that the two elements in space should also be compared with direction. So far we have compared them only as regards size. This idea may give a clue. It occurred to him suddenly during a severe illness two years ago that by introducing the idea of direction he would be able to get the additional terms that are required in regard to space to allow electro-magnetic phenomena to be included with those of gravitation and geometry.

Professor Einstein's object now is to get mathematical conditions which will satisfy all his expressions and will comprise electro-magnetic equations as well. The problem is nearly solved, and to the first approximations he gets laws of gravitation and electro-magnetics. He does not, however, regard this as sufficient, though those laws may come out. He still wants to have motions of ordinary particles come out quite naturally.

This does not finish the program by a long way. It has been solved for what he calls "quasi-statical motions," but he also wants to derive elements of matter (electrons and protons) out of the metric structure of space. No doubt much work will have to be done before this is achieved. Professor Einstein thinks, however, that the way in which he has sketched the evolution of physical ideas is the only possible one—at least to him.

The strange conclusion to which we have come is this—that now it appears that space will have to be regarded as a primary thing and that matter is derived from it, so to speak, as a secondary result. Space is now turning around and eating up matter. We have always regarded matter as a primary thing and space as a secondary result. Space is now having its revenge, so to speak, and is eating up matter. But that is still a pious wish.

THE IOWA ACADEMY OF SCIENCE

The forty-fourth annual meeting of the Iowa Academy of Science was held at Iowa State College at Ames on May 2 and 3, with 330 members and visitors in registered attendance.

The president's address, "The Ether Concept in Modern Physics," was given by Professor L. B. Spinney. The academy address, "Methods of Space Determination," was presented by Dr. C. C. Crump, professor of astronomy at the University of Minnesota. Professor Crump took the place of Dr. R. A. Gortner, of the University of Minnesota, who was detained on account of the serious illness of his son. Dr. Crump also acted as the American Association representative at this meeting. Other papers of the general meeting were: "A Statistical Test of Experimental Technique," G. W. Snedecor; "X-ray Diffraction in Water 2° to 98° C.: The Nature of Molecular Association," G. W. Stewart; "A Note on the Transneptunian Planet," D. W. Morehouse; "Some Recent Modifications of the Geological Map of Iowa," A. O. Thomas, and "Soil Bacteriology as a Science," P. E. Brown.

Grants from the academy research fund[1] were made to Professor Ben H. Peterson, of the department of chemistry, Coe College, for the purchase of special equipment for use in the study of the adsorption and coagulation of colloidal suspension by electrolytes, and to Professor L. D. Weld, of the department of physics of Coe College, for assistance in computations in an analysis of cosmic-ray observations.

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[1] The academy research fund is made possible by the refund of the American Association for the Advancement

Dr. R. E. Buchanan, dean of the Graduate School; Mr. R. I. Cratty, curator of the herbarium, and Dr. W. E. Loomis, associate professor of plant physiology, all of Iowa State College, were appointed delegates to represent the academy at the Fifth International Botanical Congress to be held at Cambridge, England.

Officers and section chairmen for the year 1930–31 were elected as follows:

President, H. L. Rietz, Iowa City; *vice-president,* J. H. Lees, Des Moines; *treasurer,* A. O. Thomas, Iowa City; *editor,* G. H. Coleman, Iowa City; *secretary,* J. C. Gilman, Ames; *press secretary,* F. J. Lazell, Iowa City; *A. A. A. S. representative,* H. W. Norris, Grinnell.

Bacteriology, B. W. Hammer, Ames; *botany,* E. W. Lindstrom, Ames; *chemistry, inorganic and physical,* R. M. McKenzie, Fairfield; *chemistry, organic and biological,* L. C. Raiford, Iowa City; *geology,* L. W. Wood, Ames; *mathematics,* G. W. Snedecor, Ames; *physics,* A. Ellett, Iowa City; *psychology,* E. O. Finkenbinder, Cedar Falls; *zoology,* H. E. Jaques, *Mt. Pleasant.*

BACTERIOLOGY SECTION

(*R. H. Walker*)

Twenty-one papers, representing many phases of bacteriology, were presented at the meeting of the bacteriology section. Among the papers dealing with general bacteriology were: "Factors Influencing the Production of Acetic Acid from Corn Stalks by Thermophilic Bacteria," by C. H. Werkman and R. H. Carter; "Further Observations on Bacteria Digesting Agar," by H. E. Goresline; "Some Notes on the Purification of Packing House Wastes," by Max Levine; "Bacteriological Studies of Freshly Broken and Frozen Eggs," by D. Q. Anderson; "Dimethyl-alpha-naphthylamine for the Determination of Bacterial Reduction of Nitrates," by C. H. Werkman, and "Some Bacteriological Problems to be Considered at the International Botanical Congress, at Cambridge, England, 1930," by R. E. Buchanan. The papers dealing with veterinary bacteriology were: "Notes on the Bacterial Flora of the Snake," by Roger Patrick and C. H. Werkman; "The Effect of the Brucella Group of Micro-organisms on Chickens," by S. H. McNutt and Paul Purwin; "The Hemoglobin Content of the Blood of Wild Fowls," by H. H. Dukes, L. H. Schwarte and F. D. Patterson, and "Coccidiosis in Swine," by Charles Murray and H. E. Biester. The papers dealing with soil and dairy bacteriology were: "Soil Bacteriology as a Science," by P. E. Brown; "Further Studies on the Nitrate Assimilating Power of Soils," by Ray A. Pendleton and F. B. Smith; "Effect of Artificial Manures on Nitrification in Carrington Loam," by F. B. Smith; "Effects of Calcium and Magnesium Limestones on the Bacteriological Properties of Grundy Silt Loam," by Arthur W. Young; "Phosphate Assimilation by *Azotobacter chroococcum,*" by L. G. Thompson; "Studies on Nitrogen Fixation by *Rhizobium meliloti* and *Rhizobium japonicum,*" by G. Gordon Pohlman; "Spontaneous Culture Studies of the Non-symbiotic Nitrogen Fixing Bacteria in the Grundy Silt Loam," by John L. Sullivan; "Studies on Nitrogen Fixation in Some Iowa Soils," by R. H. Walker; "Preliminary Observations on the Escherichia-aerobacter group of Bacteria with Reference to Dairy Products," by M. W. Yale, and "Observations on an Unusual Contamination in Butter Cultures," by M. P. Baker.

BOTANY SECTION

(*M. Rae Johns*)

The botany program was made up of thirty-two papers dealing with plants and plant problems in Iowa. Much interest was shown in C. W. Lantz's discussion of the status of biological sciences in the high schools of Iowa. Other outstanding papers were B. Shimek's discussion on chaparral and savanna in Iowa, R. P. Adams's presentation of some rare Iowa grasses and G. W. Wilson's report on some noteworthy Iowa fungi. New mosses were added to Iowa's list in papers read by Lucy Cavanagh and Betty Blagg. A. R. Stanley reported on Cladonias of Iowa; M. Rae Johns presented the second of a series of papers on Heliantheae of Iowa. In his paper, W. H. Loehwing gave the results of experiments showing the effect of light intensity on tissue fluids in wheat. J. N. Martin discussed crowns and roots of annual and biennial white sweet clover, and also polyembryony in alfalfa and clover. Miss Florence Smith presented a paper on the identification of *Symphoricarpos occidentalis.* A. L. Hershey reported on weeds of alfalfa fields in Iowa, and also discussed the development of the vascular system of corn.

There were other papers of equal interest. The session closed with an illustrated talk by L. H. Pammel on the botany of Cuba, and weeds between Cuba and Iowa. Dr. B. Shimek was the recipient of congratulations for having completed his fortieth year of membership in the academy, and also for his valued services in the interest of conservation in Iowa.

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of Science. This refund is granted the academy for the members of the academy who are also members of the association.

Chemistry Section

GENERAL AND PHYSICAL

(*Ben H. Peterson*)

Twenty-five papers were presented before the two divisions of the chemistry section. Separate sessions were held Friday afternoon, and on Saturday morning selected papers were presented to both divisions. President Hughes, of Iowa State College, was the guest of honor at the section dinner.

ORGANIC AND BIOLOGICAL

(*J. B. Culbertson*)

The organic and biological chemistry section began its meetings with a large attendance. Twelve papers were presented, two of which were given before a brief joint meeting with the inorganic and physical chemistry section on Saturday morning. There was a good distribution of papers from the state schools and colleges of Iowa. The papers presented represented researches which had been carried on in the various schools during the past year. Professor L. Charles Raiford, of the State University, was elected chairman of the section for the ensuing year.

Geology Section

(*C. S. Gwynne*)

For the geology section, the paper of most general interest was that by A. O. Thomas, in which the newest ideas with regard to the geological map of Iowa were outlined. Papers dealing with the Chemung of New York and a possible Chemung of Iowa were presented by Lowell R. Laudon, H. D. Curry and A. C. Testor. James H. Lees described the section at the Clarinda oil prospect and compared it with other sections across the state. The road materials from the Des Moines series of south-central Iowa were described by L. W. Wood, and data on maximum precipitation in short periods of time were presented by Charles D. Reed. The faunal facies of the Fort Riley limestone was described by Donald B. Gould. Other papers were presented by title.

Mathematics Section

(*John F. Reilly, Secretary*)

The nineteenth regular meeting of the Iowa Section of the Mathematical Association of America was held in conjunction with the forty-fourth meeting of the Iowa Academy of Science. A program of eighteen papers was presented, including both pure and applied mathematics. In addition the retiring chairman, Professor E. W. Chittenden, gave an address on "General Topology." Officers for the coming year were elected as follows: *Chairman*, G. W. Snedecor, Iowa State College; *vice-chairman*, E. C. Ingalls, Iowa Wesleyan College; *secretary*, J. F. Reilly, University of Iowa.

Physics Section

(*E. Hobart Collins*)

The physics section held two meetings at which thirty-one papers covering a wide range of topics were presented. A selected group of papers includes three papers by Thos. C. Poulter and students on the effect of high pressure on the index of refraction of paraffin, oil and glass, studies of zinc fluorescent screen under pressure and recent developments in high pressure windows. There were four papers concerning the improvement of research and teaching apparatus and equipment. William Kunerth presented two papers on skyshine and sunshine at Ames, Iowa, and minimum lighting intensities required for reading. Students of A. Ellett presented two papers on optically excited cadmium spectrum and reflection of zinc atoms from NaCl crystals.

Psychology Section

(*W. E. Slaght*)

The attendance at the recent meeting of the psychological section of the academy was the largest since its reorganization some five years ago. In all, nineteen papers were presented. Five were in the field of educational psychology, six in experimental and two in applied psychology. Three papers dealt with problems of child study. A very interesting presentation dealing with the abnormal was a study of "The Relationship between Recent Impressions, and Factors Occurring in Dreams Induced by Them," by William Malamud. At the dinner of the psychological section an able address was given by C. A. Ruckmick on "Present Trends in Psychology." Those attending the section meetings were delightfully entertained by the members of the psychological staff of Iowa State College.

Zoology Section

(*J. E. Guthrie*)

The zoological program ranged from the protozoan rôle in ruminant stomachs by E. R. Becker and R. E. Everett, who find that they seem neither markedly harmful nor useful to their hosts; to the bison in Iowa by L. H. Pammel, who records its presence in the fifties, and its former abundance. Text-books have long taught error regarding the shark's ear, as H. W. Norris showed. The goldfish development of ovary and oviduct was beautifully illustrated and described by Frank A. Stromsten. R. G. Anderson reported interesting studies of rates of regeneration in mutilated *Daphnia magna*. The little-known insects known as springtails are shown by H. B. Mills to have some economic importance, both positive and negative. Another white grub distribution paper by H. E. Jaques showed records for 1929. Two studies of winter bird records in Iowa by T. C. Stephens and William Youngworth showed a larger winter list than expected. Walter W. Bennett emphasized what should be studied and recorded about birds in Iowa now. George O. Hendrickson's "Teaching of Biology in Iowa Schools" awakened keen discussion.

JOSEPH C. GILMAN,
Secretary

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN APPARATUS FOR THE PREPARATION OF SMALL ORGANISMS

THE apparatus herein described permits the preparation of micro-organisms and small whole mounts in such a manner that (1) the change in concentration of a reagent and from one reagent to another is gradual, (2) the organisms remain on the same cover glass without the application of an adhesive agent from the time they are killed until the process of mounting is completed and (3) the objects may be viewed under the microscope during any stage of the process.

DESCRIPTION

A block of wood (Fig. 1) supports three vertical cylindrical rods each $\frac{1}{4}$ in. in diameter and 20 cm long. An arm 11 cm long extends horizontally from each rod. One end of the arm bears a spring clamp for the securing of a small shell vial, the other is fitted with a collar and set screw permitting easy adjustment of its position on the vertical rod. The three shell vials *A*, *B*, *C*, of a size appropriate to the demands of the technique used, are connected by small capillary tubes. From vial *C* a capillary leads into the chamber *D* containing the organisms. The glass capillary which serves as an outlet from this chamber leads into the constant level device at *E*. The latter consists of a glass cylinder 1.5 cm in diameter and 5 cm long. At the bottom is a cork through which is inserted the capillary shown at *F* which is somewhat greater in diameter than that of the outlet capillary from *D*. The height of the top of the capillary *F* is equal to the fluid height desired in the chamber. The chamber *D* is elevated on a glass-topped table, the dimensions of the latter being adequate to permit the insertion of a microscope stage so that the preparation may be within the field of the objective.

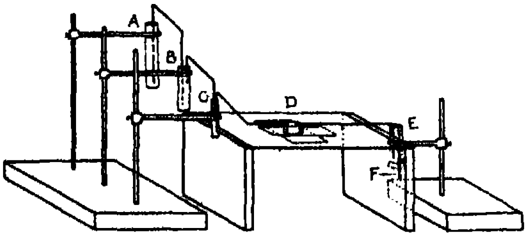

FIG. 1

THE REAGENT CHAMBER

This part of the apparatus (Fig. 1, *D* and Fig. 2) consists of a clamp formed of two brass plates 4 cm by 5 cm, each of which is drilled through the center with a circular hole 21 mm in diameter. Two pillars, shown at *g*, fashioned from No. 8–32 by $\frac{7}{8}$ in. brass machine screws are set 3.5 cm apart on the median long axis of the lower plate *a*, and corresponding holes at *g* are drilled in the upper plate so that it may be slipped over the pillars and clamped by wing nuts. A 1 in. by 3 in. glass slide *b* is placed on the bottom plate between the pillars; at *c* is a 22 mm square cover glass over which lies a thin circular cork washer *d* with internal and external diameters of 20.5 mm and 22 mm respectively. Upon this washer is placed a glass cylinder *e* 8 mm high, the circular dimensions being the same as those of the cork washer. The upper and lower surfaces of the cylinder are ground in order that the faces may be smooth and parallel. At opposite ends of a diameter, on the upper surface of the cylinder, areas are filed away sufficiently large enough to permit the intake *i* and outlet *o* capillaries to enter the chamber without extending above its surface. The intake and outlet capillaries are sealed to the chamber at their points of entrance with dental cement. The chamber is made fluid tight by adjusting the upper brass plate over the cylinder and firmly and evenly clamping it by means of the wing nuts at *g*.

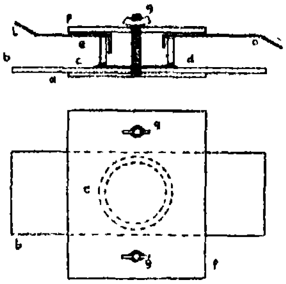

FIG. 2

METHOD OF OPERATION

The organisms are introduced into the chamber and the killing agent applied with a pipette. The reagent to follow is placed in vials *A*, *B*, *C* (Fig. 1). From then on, changes in reagents or concentrations are made in vial *A*. Vial *B* is a preliminary mixing chamber, and vial *C*, usually much smaller than the other two, completes the solution or equalization of the reagents.

After the final process of clearing is complete, the excess reagent is removed from the chamber by a pipette, the clamp is released and the cover glass inverted over a drop of balsam placed on a slide.

Corks with holes for the entrance of the capillaries may be placed in the vials to prevent evaporation, also a large cover glass should be placed over the chamber when the process is not being observed under the microscope. If a capillary fails to function because of the presence of air bubbles, the intake capillary of the vial from which it leads is removed. Then, a mouth pipette is inserted through its place in the cork and an air pressure exerted sufficient to cause the resumption of flow through the capillary.

The flow into the chamber containing the specimens is so gradual and the mixture of the reagents entering it has been found to be so complete that small protozoa will remain stationary on the cover glass and not be carried by convection or solution currents into the drain leading from the chamber.

PAUL L. RADIR

UNIVERSITY OF HAWAII

SPECIAL ARTICLES

THE EXPERIMENTAL TRANSMISSION OF YELLOW FEVER BY MOSQUITOES[1]

FOR many years yellow fever has been one of the most dreaded of the diseases menacing the human race in the warmer parts of the western hemisphere. The rapid conquest of its frontiers has been one of the great achievements of modern warfare on disease.

Ever since the memorable work of the American Commission (Walter Reed *et al.*) established *Aedes aegypti* as an essential host in the yellow fever cycle, epidemiological studies and palliative measures have revolved about the domestic relationships of this so-called yellow fever mosquito.

In addition to experiments with this species, the Americans[2] in Cuba and the French Commission[3] in Brazil, using human volunteers, attempted the passage of yellow fever through *Culex quinquefasciatus* (=*fatigans*), an important human pest widely distributed in the tropics. The French Commission also undertook transmission experiments with *Aedes scapularis, A. taeniorhynchus, Psorophora ciliata* and *P. posticata*. None of these experiments were successful.

More than two decades later, in West Africa, Bauer[4] carried out the first successful transmission experiments with species other than *A. aegypti*. The belief that the dreaded "yellow jack" was transmitted solely through the agency of the notorious *Stegomyia* mosquito had been of so many years' standing that the experimental transmission of the virus of this disease by several other species of mosquitoes came as a rather startling confirmation of the predictions of the late Dr. H. R. Carter.

In Dr. Bauer's experiments, *Aedes* (*Stegomyia*) *luteocephalus, A.* (*Aedimorphus*) *stokesi*[5] and *Eretmopodites chrysogaster* were allowed to bite infected rhesus monkeys. After an adequate incubation period, these insects were induced to feed on normal animals and were injected into other test monkeys. All produced fatal infections in the test animals. *A. apicoargenteus* did not transmit the virus. The negative results with this mosquito, a *Stegomyia*, and the positive findings for *Eretmopodites* are especially remarkable.

Continuing studies on West African species I added to the list of experimental vectors three more stegomyiae, *viz.*, *A. africanus, A. simpsoni* and *A. vittatus*, as well as an important domestic mosquito of another genus, *Teaniorhynchus* (*Mansonioides*) *africanus*.[6] *Anopheles gambiae*, the chief malaria carrier of the region, fortunately proved to be incapable of maintaining the virus of yellow fever in its system through the accepted incubation period.

Several other species with which I made transmission tests (unpublished) produced no reaction by bites, but injections of saline suspensions of the vicious crab-hole mosquitoes, *A.* (*Aedimorphus*) *irritans* and *A.* (*A.*) *nigricephalus*, as well as of *A.* (*Banksinella*) *punctocostalis* and *Culex thalassius*, resulted in fatal infections, after the elapse of adequate incubation periods following the initial infecting meal. I was also able to confirm transmission of the virus by *A. luteocephalus*.

In view of the findings in West Africa Davis and Shannon[7] recently reopened the question of the possible transmission of yellow fever by South American species of mosquitoes other than *Aedes aegypti.*

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[1] The studies and observations on which this article is based were conducted in Lagos, Nigeria, with the support and under the auspices of the International Health Division of the Rockefeller Foundation.

[2] W. Reed, J. Carrol and A. Agramonte, Senate Document No. 822, 1911, 110.

[3] E. Marchoux and P.-L. Simond, *Ann. Inst. Pasteur*, 25: 23, 1906.

[4] J. H. Bauer, *Amer. Jour. Trop. Med.*, 8: 261–282, July, 1928.

[5] A correction in name from the original report of *A. apicoannulatus* as pointed out by Evens, *Ann. Trop. Med. and Parasit.*, 23: 521, 1929.

[6] C. B. Philip, *Am. Jour. Trop. Med.*, 9: 267, 1929; 10: 1, 1930.

[7] N. C. Davis and R. C. Shannon, *Jour. Exp. Med.*, 50: 803, 1929.

There are no close relatives of *A. aegypti* in the western hemisphere, but these investigators have shown that *A.* (*Ochlerotatus*) *scapularis* is capable of producing typical infections by biting normal monkeys, that injections of macerated specimens of *A.* (*O.*) *serratus* may result fatally and that injections of *A.* (*Taeniorhynchus*) *taeniorhynchus* produce a mild infection; the bite of the two last-named mosquitoes did not prove infective, however. Negative results had previously been reported in experiments with *A.* (*Taeniorhynchus*) *taeniorhynchus* and *A. scapularis.* No definite infection was obtained by Davis and Shannon with *C. quinquefasciatus,* either by bite or injection; however, three test-animals bitten by these mosquitoes were reported to have remained "relatively immune" when given susceptibility tests.

A total of twenty-five investigations with twenty-two species of mosquito representing five genera has been reported by all the investigators mentioned above. Nine of these species (including *A. aegypti*) transmitted yellow fever by bite; six others transmitted it by injection only; six did not transmit the disease, and in one case (*C. quinquefasciatus*) the result was doubtful. A table is presented below, summarizing the present knowledge with regard to the species of mosquitoes which have been induced to bite infected humans (first two investigations) or monkeys (last three investigations), and have subsequently been tested by bite or injection. *A. aegypti* is included only once, although it has given positive results in the other investigations.

SPECIES OF MOSQUITOES KNOWN TO PRODUCE YELLOW FEVER IN HUMANS AND IN MONKEYS, BY BITE OR INJECTION

Reported by	Total species tested	Positive by bite	Positive by injection only	Negative
Western Hemisphere				
Reed, Carrol and Agramonte	2	1	......	1*
Marchoux and Simond	5	0	......	5†
Davis and Shannon	4	1‡	2†	1*
West Africa				
Bauer	4	3§	0	1
Philip	10	5§	4	1

Species tested in two investigations:

* ***Culex quinquefasciatus*** **(three test animals reported relatively immune by Davis and Shannon).**

† ***Aedes taeniorhynchus.***

‡ ***Aedes scapularis.***

§ ***Aedes luteocephalus.***

The number of tests carried out with the crab-hole *Aedes* in Nigeria, as well as the other observations tabulated in the third column of the foregoing table, indicate that in certain species of mosquitoes complete distribution of the virus throughout the body does not occur, under ordinary conditions at least. *A. irritans* has retained the virus for as long as fifty-one days, as proved by subsequent injection, without transfer in biting experiments. Transmission by such unrelated genera as *Eretmopodites* and *Taeniorhynchus* is deserving of note.

While the fight against yellow fever has heretofore proved efficacious in the Americas when centered about control of the *Stegomyia* mosquito alone, increasing information on West African conditions indicates a considerable complexity of factors in that region. It may well be that certain of the potential vectors mentioned above play an important rôle in the dissemination of yellow fever there. This seems all the more likely when one considers that infected persons are probably capable of infecting insect carriers at least a day before the appearance of clinical symptoms. Hudson and Philip[8] have shown that experimentally infected rhesus monkeys may infect mosquitoes one or two days before the onset of fever. If the infective period in humans is similar to that in monkeys mosquitoes would not necessarily have to be house-frequenting species exposed to febrile cases in order to pick up the virus.

Bionomical studies have convinced me that *T. africanus* is the most likely of the potential vectors to be of epidemiological importance in West Africa. It bites humans with avidity, feeds more than once, is present in houses at all seasons in limited numbers and during certain seasons in considerable numbers. Mr. Edwards, of the British Museum, has supplied the information that this species has been captured in the Far East and even in Australia, although its congener, *T. uniformis,* is more abundant in Egypt and through the Orient, as far as the Philippines and Solomon Islands. *T. uniformis* is found occasionally in West Africa and may also be a vector of yellow fever.

It is logical to predict that as further experiments are undertaken several other species of mosquitoes will be found capable of transferring the disease, particularly *Aedes metallicus* and *A. dendrophilus,* both of which are found in moderately large numbers in tree-holes in Nigeria.

CORNELIUS B. PHILIP

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[8] N. P. Hudson and C. B. Philip, *Jour. Exp. Med.*, 50: 583, 1929.

ON THE CHEMICAL ECOLOGY OF LAKE TANGANIKA

Cunnington,[1] in his summary of our present knowledge of the natural history of the Great Lakes of Central Africa, has emphasized the unique nature of Lake Tanganika. This lake is distinguished biologically on the one hand by the very large number of endemic species inhabiting it, and by the absence of certain widely distributed organisms on the other. The most noteworthy deficiency concerns the Cladocera, which are entirely lacking from its waters though present in the inflowing rivers.[1,2,3] A similar condition is met with in Lake Kivu.[4] Cunnington, on the basis of analyses given by Stappers,[5] suggests that the absence of Cladocera is due to the large quantity of magnesium present in the waters of the lake. Reference to the literature shows that numerous localities, containing considerably more magnesium than found by Stappers, support a Cladoceran fauna. Recently I have had the opportunity of examining a specimen (135 cc) of coastal surface water from Lake Tanganika which was very kindly collected for me by Dr. Rollin T. Chamberlin, of the University of Chicago. As a result of an examination of this sample and of certain experiments bearing on the problems of the lake the following data can now be presented.

Hydrogen ion concentration.—The pH value of Dr. Chamberlin's sample when opened was 8.7. On boiling, a faint precipitate of alkaline earth carbonates was produced at 9.1. Some decomposition of organic material may have occurred in the water while in the bottle, making it less alkaline than when in the lake. We may conclude that the surface waters of the lake have a pH value between 8.7 and 9.1, and that it probably lies nearer the former figure than the latter. The water therefore is alkaline, but not excessively so, as are some of the smaller Central African Lakes.[6]

Phosphorus content.—Phosphate present in solution after boiling was determined colorimetrically by the cerulomolybdic method; a value of 0.08 milligrams per liter of phosphorus was obtained. It was unfortunately not possible to determine "total" phosphorus, but since the water had been kept a long time before the determination this value probably more nearly approximates to the original "total" than "soluble" phosphorus. It is high when compared with the values for "total" phosphorus (.015–.040 milligrams per liter) obtained by Juday, Birge, Kemmerer and Robinson[7] for the surface waters of the Wisconsin Lakes but is low compared with the large amounts obtained in other alkaline localities, as the Transvaal pans examined by Hutchinson, Pickford and Schuurman[8] (*N. B.*, read .006 grms per liter P_2O_5 for .006 mgms per liter). It appears that at least the coastal waters of the lake do not suffer from a deficiency in this element.

Radioactivity.—In view of recent work on the production of mutations by irradiation it appeared possible that the very high endemicity of the fauna of the lake might be due to an unusual amount of radioactive material dissolved in the water. Gas boiled off from the water sample after it had been sealed for a month gave no indication of radioactivity when transferred to an emanation electroscope.

Toleration of magnesium salts by Cladocera.—Several species of Cladocera have been raised in cultures containing more magnesium than is indicated for Lake Tanganika by Stappers' analyses without ill effects. Moreover both *Daphnia magna* Straus and *D. longispina* O. F. M. have been cultured in solutions made up to contain all the salts of the lake and maintained at a pH of 8.5–8.9. It would appear therefore that other than chemical factors are responsible for the absence of this group from Lake Tanganika.

I am greatly indebted to Dr. R. T. Chamberlin [illegible] collecting and bringing back the water sample, [illegible] to Dr. Douglas Johnston, of Columbia Univer[illegible] for asking him to do so. I also wish to thank Dr [illegible] F. Kovarik for lending an electroscope, and the [illegible] gian Colonial Office for a transcript of Stapp[illegible] analyses, which are apparently not available in [illegible] country.

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[6] Jenkin, *Nature*, 124: 574, October, 1929.

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[8] *Nature*, 123: 832, June, 1929.

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PROGRESS OF MEDICINE DURING THE PAST TWENTY-FIVE YEARS AS EXEMPLIFIED BY THE HARVEY SOCIETY LECTURES[1]

By RUFUS COLE, M.D.

THE HOSPITAL OF THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH

The constitution of this society states its object to be the diffusion of knowledge of the medical sciences, or, more specifically, "the diffusion of scientific knowledge in selected chapters in anatomy, physiology, pathology, bacteriology, pharmacology and physiological and pathological chemistry." This statement implies that these sciences form the foundation on which the superstructure of medicine is built. That medicine itself is omitted from this catalogue of sciences suggests that medicine is something different, that as an independent branch of human knowledge it does not exist, or, if so, that its content and the methods for its pursuit are not of a character to justify its inclusion in this family of sciences. Time would not permit me, even if it were profitable, to discuss the justification for this attitude, but I may point out the great and important change that has taken place in the past twenty-five years toward this point of view. The independent position which this discipline now occupies in certain universities, its elevation to a rank equivalent to that of the other sciences mentioned and its disinterested pursuit by men whose chief object is its advancement indicate one of the most striking changes which has occurred in medicine, and to-day, if the constitution of this society were to be written, its object would probably be stated to be the diffusion of scientific knowledge in medicine and related sciences.

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[1] Address given at the celebration of the twenty-fifth anniversary of the founding of the Harvey Society, at the Academy of Medicine, New York City, May 15, 1930.

For this reason, as a humble disciple in this new science, yet one of the oldest, I feel gratified in being asked to discuss briefly the changes that have taken place in it during the past quarter century. Possibly the simplest way to approach this task would be to analyze carefully the entire series of lectures, pick out the new facts, or apparent new facts, presented by each one of the speakers, carefully catalogue and index and group them, possibly give them a statistical treatment, and then present to you my results, and conclude with an apotheosis of modern science, particularly of those sciences in which we are interested, not forgetting to point out the great and beneficent practical results that have been attained. I have preferred, however, to consider this subject in a somewhat different manner, and if I sometimes seem to strike a critical note I trust you will remember that I have endeavored to consider my subject in a purely objective and disinterested manner, as befits this society.

The historian of an epoch is usually granted a retrospection of a sufficiently distant past that he can discriminate between the momentous events of the period and the less significant details which are apt to be magnified in the eyes of contemporaries. For one who has lived in the midst of events to attempt, at the end of so short a period as twenty-five years, critically to survey that period is a hazardous undertaking. Moreover, no period in history can be satisfactorily isolated from that which precedes and follows.

That changes in concepts are constantly occurring, new facts being brought to light, in medicine, as elsewhere, is obvious to all. What we are considering, however, is not change but progress. With the exception of a few philosophers, people of to-day believe in progress. It is almost axiomatic. But man did not always accept that assumption. The Greeks kept looking to the past as the halcyon days and longed for their return. It was only at the end of the eighteenth century, when the multiplication of discoveries in natural science enormously amplified knowledge of the environment, that the idea of progress was clearly formulated and became generally accepted, and that man became so hopeful of the future.

To-day we have to ask ourselves not whether medicine has progressed but at what rate progress has occurred. The scientist would have great difficulty in finding a formula by which to solve this problem. The only method that suggests itself is that of comparison. Let us, therefore, take a sample period from times past, and for a few minutes consider an imaginary course of Harvey Society Lectures given a hundred years ago, from 1805 to 1830. Who might have been our lecturers and of what progress could they have told us?

This era is not considered by historians an outstanding one as regards medical progress, but we are prepared for some advances, since in other realms of human interest men's minds showed no signs of sterility. Keats and Shelley were making their great additions to English poetry; Beethoven during this period composed all but two of his symphonies, and Goethe wrote "Faust," besides making contributions to comparative anatomy and metamorphosis of plants of no mean importance. Rapid changes were also taking place in men's habits of life. The steam locomotive was being developed, gas was becoming a common illuminant in the houses and streets, thus making transportation more rapid and lengthening men's hours of activity.

In our hypothetical course we should not have had many lecturers dealing with infectious diseases, but we should have had Edward Jenner. The subject of his lecture would, of course, have been vaccination, but he could also have told us something about the reactions (now called allergic) which he had observed in vaccinated persons who had previously had smallpox. Daniel Drake would have been invited to speak on epidemiology, although his classic book on "Diseases of the Interior Valley of North America" was not published until somewhat later. Possibly he would rather have spoken on medical education, since his papers on this subject have been called "the most important contributions ever made to this subject in this country." We should also have asked Elisha North to come down from New London and talk about cerebrospinal meningitis, as his book giving the first description of this serious disease was published in 1811. There were other American physicians and scientists (most of the scientists of those days were physicians) who might have been invited, but then, as now, we should have endeavored to obtain as much foreign talent as possible. Auenbrugger was getting too old to make the long journey, but after the publication of Corvisart's book in 1818 we should certainly have invited him to come over and discuss the new method of percussion. An invitation would also have been sent to Piorry to address us on mediate percussion and to show his pleximeter. Laënnec would, of course, have given us a lecture, and not only demonstrated his stethoscope, but told us about a half dozen chest diseases we had never heard of. Louis would have been one of our best lecturers, for he could have presented abstracts from his masterly book on phthisis or from that on typhoid fever. But, more important, he could have told us much about the new so-called numerical method for studying disease. His method, however, was not very complicated, the essential features of it consisted in making careful observations and keeping records. He would not have presented very complicated mathematical formulas. Moreover, it would have been interesting to have had a full-time teacher of medicine. He was one of the first. There would have been a very distinguished group of clinicians among the lecturers; Bretonneau would have lectured on diphtheria; John Cheyne would have talked to us about a peculiar type of respiration; Robert Adams, about heart block, although he did not give it that name; Thomas Hodgkins, about a new disease of the glands, and of course Sir Dominic Corrigan, who would have given a lecture on the pulse. One of the best lecturers would have been Richard Bright, who in 1827 published his description of nephritis. Several years earlier we might have had a lecture by William Charles Wells, a native of Charleston, who, in 1811, pointed out the relationship between dropsy and albuminous urine and thus prepared the way for Bright. We should thus have presented to our New York audience the two men who have made the most important observations concerning nephritis from that day to this. A German clinician whom we should have attempted to obtain as lecturer was Schönlein, for he would have addressed us concerning the importance of examinations of the blood and urine, especially chemical examinations, as he was an ardent advocate of this kind of clinical study.

But besides physicians we should then, as now, have invited anatomists and physiologists, chemists and physicists. Among the anatomists, we should have invited Lamarck and Cuvier, and also the German comparative anatomist Johann Friederich Meckel, who, as you know, was also a pathologist.

Unfortunately, John Hunter had died ten years before our course began, and Claude Bernard was not born until 1813, but we should have had Magendie, who would probably have spoken of his experiments concerning digestion. He might also have described his observations regarding sensitization to egg white. Johannes Müller was a little young, but he might have come over at the very end of the course and lectured on "Law of Specific Nerve-energies." We should earlier have had a lecture by Sir Charles Bell on the differentiation of sensory and motor nerves, but Müller would have elaborated and developed this theme. Our own William Beaumont would certainly have been invited to speak on the physiology of gastric digestion, and I imagine he would have been so pleased by the invitation that he would have brought Alexis St. Martin with him for demonstration.

There would have been some chemists, too, of first-rate standing. At the very end of our course we should have invited Liebig, even though he were still quite young. He discovered hippuric acid in 1829, and the year before his associate, Wöhler, had succeeded in synthesizing urea, so we should have made a great effort to get one or both of them. Humphry Davy, or Sir Humphry if he had not come before 1812, would have been one of our most popular lecturers. He would have brought his apparatus and performed experiments before us as he did at the Royal Institution. He would probably have demonstrated the anesthetic effects of nitrous oxide on some member of the audience.

We might have had one or two physicists also, although at that time their work did not seem to have any direct relation to medicine. However, Thomas Young was a doctor and he might have lectured on the differences between the physical and physiological properties of light, or even on the circulation. At the dinner before the lecture he might have told us something about his deciphering the Rosetta stone.

It is true that some of the men I have mentioned might have been overlooked when sending out the invitations to lecture before the Harvey Society. Certain of them were ignored by their associates; others were openly opposed. Some who were most loudly acclaimed in their day are now ranked much lower.

I have described this hypothetical course of Harvey Society Lectures in the years 1805 to 1830 in order to recall to your minds the state of medicine one hundred years ago, and to indicate the kind of men who were making contributions to medicine during these years. It is evident that the chief advances being made were in somewhat different directions than those in which the advances during our own era have occurred. There was great activity in clinical description and in the differentiation of diseases. The center of medical advance was undoubtedly in France, where new methods of clinical investigation, which even to-day are of first importance, were being devised. Physiological discoveries of great significance in pathology, especially as concerns diseases of the nervous system and of the digestive tract, were being made. Finally, advances were being made in chemistry and physics which were of material aid in increasing knowledge about disease. It is evident, however, that comparatively little of this advance originated in America. In our hypothetical course of lectures most of the talent would have had to be imported.

As has always been the case in science, the discoveries of the period are associated with the names of individuals, and as time has passed these men have received an ever-increasing glorification. Nevertheless, they must have had great intellectual vigor and possessed high powers of imagination. This is evident not only from the methods they employed in solving their problems but from the actual height of the steps which were mounted. Starting with little knowledge, they scaled great heights with comparative suddenness.

During the seventy-five years which elapsed between our hypothetical course of lectures and the opening of our present course in 1905 important advances were made. During this period occurred the development of experimental physiology, and later the extraordinary growth in pathological anatomy, especially that which resulted from the formulation of the cell theory. Then came the important discoveries regarding infection and immunity, which increased knowledge concerning disease as had never occurred before. The advance in medicine in the last third of the nineteenth century will undoubtedly always be considered to be related to infectious diseases.

In the middle of the century physiology had turned its back on vitalism and maintained the possibility of a physicochemical explanation of all life phenomena, going even so far as to maintain that in the "ultimate analysis biology is only a branch of physics and chemistry."

The great increase in knowledge of the structure of the proteins which took place around the turn of the century led to high hopes that an understanding of these substances would go far in revealing even the nature of life itself. Advances in chemistry were not confined to structural chemistry, however, but a new science developed which had for its parents both physics and chemistry, and had for its content the dynamics of chemical reactions. Shortly before the opening of our era the possibility of direct measurements of energy exchange in man was made possible by the construction of chambers in which men, even sick men, could be studied with the greatest attention to detail.

At the beginning of the era we are considering, therefore, rapid progress in the knowledge of infectious disease was occurring. Progress in organic chemistry was at a high level, and probably this field seemed to offer the greatest hopes for fundamental advances in biology and medicine. There was developing a tendency to lay emphasis upon the importance of studying biology from the dynamic standpoint, "regarding an animal as something that happens."

Germany was at the height of her activity and a greatly increased momentum was observable in this country in the study of the underlying features and phenomena of disease.

Thus was the stage set for the course of lectures designed to promulgate the new knowledge concerning disease as fast as it should be disclosed. It was a happy and fortunate inspiration which in 1905 led Dr. Lusk, Dr. Meltzer and a group of their associates to found this society, at a period when interest in scientific medicine was beginning to glow more bright, not only in New York but throughout this country.

The Harvey Society Lectures do not deal with any single phase of human biological phenomena. They represent a sort of symposium in which workers from various fields of science report their results. In choosing the lecturers, however, the attempt is made to bring together men who have some interest in the problems of human disease, though it is realized that at times this interest may be very remote. In discussing the advances in medicine which the lectures disclose, therefore, one must carefully delimit the field and not include all the results presented. For example, it might be very advantageous for physiologists to have a course of lectures in which physicists, chemists, psychologists, geneticists, anatomists, bacteriologists, even mechanical engineers were asked to speak. They might all contribute new knowledge which would be very important for physiologists to know about, and new facts which might have a very close bearing on physiological problems. Yet one could not assume that all the discoveries in these various fields represented new contributions to physiology. In the past there has been a tendency to assume that all contributions to physiological knowledge or that all advances in biological chemistry represent advances in medicine. Indeed, it has even sometimes been intimated by the votaries of these and certain related sciences that the advances in these sciences form the only contributions to medicine that are of real importance. In my opinion, both physiology and medicine have suffered from this concept.

As has been pointed out, "the various branches of science are not limited by the training and antecedent interests of the persons who cultivate them, but are defined by their subject-matter." Medicine has for its subject-matter disease in its various aspects, and disease involves modification of function, but it also involves modification of structure, whether this be conceived of only in its more superficial aspects, morphology, or its more intricate nature, chemical or physical. But not all modifications of function or structure constitute disease, at least in a practical sense. Although any disturbance of function is probably accompanied by alterations throughout the entire organism, medicine is really concerned with particular, usually gross, alterations in certain specific functions which constitute the symptoms of disease.

Medicine has for its field phenomena which occur in nature, not hypothetical possibilities. The student of disease is interested not only in describing and understanding these disturbances, but in determining the factors, intrinsic or extrinsic, on which they depend. And, just as in the other sciences, even physics, its disciples are interested in obtaining accurate knowledge in order that predictions may be made, and even that the natural course of events may be modified.

The student of disease is interested in all physiological problems for the light that may be thrown on disease processes. The student of physiology is interested in certain problems of disease for the light that may be shed on physiological problems. But he is not interested in all problems of disease, except as matters of general interest. He is not primarily interested in etiology or causation, so far as they relate to external agents, or to environment; he is not keenly interested in the voluntary modification of disease processes, or therapy; he is not deeply interested in the psychological aspects of disease. He is not necessarily interested in disease at all. The interests of the student of physiology and those of the student of medicine overlap, but they are not identical, nor are the contents of these two sciences identical. Virchow was wise enough to see that "each department of medicine must have its own field and must be investigated by itself." As he said, "Pathology can not be constructed by physiologists, therapeutics not by pathological anatomists, medicine not by rationalists," nor, may be added, by chemists, physicists or mathematicians.

If our attention is confined to the results presented before the Harvey Society it will be necessary to omit from consideration certain special fields relating to medicine which have barely been touched upon in these lectures. This is especially true as regards psychiatry and the pathology of the nervous system. Such important developments as conditioned reflexes, the study of behavior, the newer modes of thought concerning psychoanalysis and psychotherapy have been considered very briefly if at all. So too in these lectures comparatively little attention has been given to the great advances which have been made in surgery, not only as regards the technique of operating and maintaining asepsis, but also as concerns the improvement in methods of diagnosis and treatment of so-called surgical conditions, advances which are based on recent discoveries in physiology.

We shall also have to omit from consideration certain great movements, such as the *organization* of private and governmental agencies, and of the medical profession, whereby applications of new knowledge concerning disease can be made rapidly and to a previously unbelievable extent. This has certainly been an outstanding feature of the present quarter century.

Medical education has undergone an extraordinary extension, and a very striking modification in method, especially as concerns organization and teaching, has occurred in the medical clinics during this period. Whatever the effect these changes may have had on the education of students, and thus on practice, they have resulted in a tremendous increase in the opportunities for the investigation of disease. These opportunities consist not only in better material equipment in the way of laboratories, but also in protection of the followers of the science of medicine from the burdens of private practice.

These are all matters which have been very lightly touched upon in the Harvey Society Lectures, but they can not be neglected when thinking of the history of medicine during these twenty-five years, as it will be written by our followers.

To point out certain specific outstanding contributions to medicine is not difficult. Knowledge concerning several important diseases has been enormously increased.

One of these diseases is syphilis. At the time the course of lectures began the nature of the inciting infectious agent was unknown and diagnosis depended entirely on superficial clinical features. The relationship of tabes and general paralysis to this infection, though strongly suspected, was uncertain. Its treatment was fundamentally that of a hundred years before. During the period, the inciting agent has been isolated, even cultivated, and in most instances may be demonstrated in the lesions; a reliable, accurate, purely objective, quantitative method of diagnosis has been devised; the specific nature of tabes, general paralysis and of many other manifestations of the infection, such as aortitis, has been established, and finally a greatly improved method of treatment has been devised. Moreover, the disease has been produced experimentally in animals, and very much knowledge concerning the mode of infection and the reactivity of the host, as exhibited by hypersensitiveness and immunity, has been obtained. Hardly in the whole history of medicine has such a striking increase in knowledge concerning any important disease occurred within so short a period as twenty-five years.

Also a great increase in knowledge has occurred concerning certain forms of heart disease. Shortly before the beginning of our course of lectures anatomical studies had demonstrated the presence in the heart of special fibers having the particular function of conducting the impulses giving rise to contraction. Through the intensive study of arrhythmia in patients, at first by very simple instruments, even by direct observation and palpation of the arterial and venous pulse, and later with the aid of a galvanometer especially suited to the study of these problems, it has been possible accurately to localize the specific lesions upon which the various types of arrhythmia depend. Knowledge has also been gained concerning the effects of certain drugs in modifying rhythm, and as a result it has been possible to employ these drugs with greatly increased accuracy and efficiency.

At the beginning of the era knowledge concerning diabetes was fragmentary. Much was guessed but little was known. During the past twenty-five years many facts concerning the metabolism of sugar in health and in disease have been disclosed, the underlying factors in the production of coma have been determined, the disease has been accurately reproduced in animals, the demonstration has been made that a substance secreted by the pancreas greatly influences sugar metabolism and that the disease is associated with the lack of this substance and, finally, a practical method of supplying this substance, when lacking, has been devised, so that the symptoms of the disease may be made to disappear.

The more recent contributions to knowledge concerning pernicious anemia are also significant. This most serious malady has remained one of the mysteries of medicine ever since its description by Addison in 1849. Now, by a series of experimental studies, not only has a practical therapeutic measure been found, but it seems not unlikely that much progress has been made toward understanding its essential nature. The culminating discovery that in this disease the production of new red blood cells may be stimulated by the intravenous injection of a few drops of a solution of a substance normally present in liver, and to a less extent in other tissues, signalizes a notable triumph for the experimental method.

The discovery that in rickets the phosphorus as well as the calcium metabolism is disturbed, the demonstration of the therapeutic value of sunlight in this disease and especially the demonstration of the remarkable fact that anti-rachitic properties may be conferred upon particular fatty substances by exposing them to ultra-violet light rays of definite wavelengths, and that the specific reaction which is thus induced consists in a polymerization of ergosterol, seem to me to be of extraordinary theoretical interest as well as of practical value.

These are a few of the diseases concerning which striking and significant new knowledge has been obtained. They have been specifically mentioned because in these instances, as a result of new knowledge, improved methods of treatment have been developed. In many other instances, however, although no practical results have so far been obtained, much has been learned about particular pathological phenomena.

In all these cases various sciences have contributed to the advances, although it is impossible to evaluate the relative importance of the rôle which each of them has played. While in most instances the discoveries did not depend upon the most recent advances in physics and chemistry, it is certain that they could not have been made in the absence of the organized systematized knowledge which comprises natural science. Nor could they have been made without the growth in anatomical and physiological knowledge which has occurred during the past three hundred years. The facts of importance to medicine, however, did not emerge spontaneously from the accumulated knowledge of the past. In most instances the discoveries were made because some one was interested in the problems of the particular disease, and because some one thought of a new way of solving these problems, using of course for this purpose any of the accumulated knowledge, or any technique of any science, that was suitable for his purpose. This is not only the prerogative and custom of the followers of the science of medicine but it is the method employed in every other science, including that of physics.

In certain of the instances which I have mentioned, the discoveries were not the outcome of entirely new modes of thought or procedure. The emergence of these discoveries can be traced to specific preceding discoveries which supplied the example or pattern to be followed. For example, in several instances the discoveries have to do with so-called internal secretions of the ductless glands, or with a deficiency of these secretions. In the middle of the last century clinicians observed that, in individuals who exhibited special groups of symptoms, pathological lesions were present in certain glands. This was a discovery of great significance which physiology owes to medicine. It was found that in certain instances removal of these glands from animals was followed by symptoms similar to those seen in patients in whom the same glands were affected. Gradually evidence accumulated which indicated that in some cases the function of the diseased glands could be replaced, at least in part, by feeding the fresh glands of normal animals, by grafting, or better, by injecting extracts of these glands. The conception, however, that these glands secrete chemical substances, or "messengers," by means of which "correlation of the functions of the organism are brought about through the blood, side by side with that which is the function of the nervous system" is a physiological principle well established only in the present era, and one which is probably of great significance both to physiology and to medicine, and may possibly prove to be the most important contribution made to medicine in the present era. The fact that at least two of these "messengers," or hormones, have been isolated, and their chemical constitution established by American workers, exemplifies in a striking manner the interdependence and helpfulness of the various sciences, and also indicates the important position which American investigators have come to occupy.

Another example of chemical coordination through the blood was given by the discovery that the respiration is regulated by the carbon dioxide tension of the arterial blood, or more properly, by the H^+ ion concentration of the arterial blood, acting on the respiratory center. The physiologic importance of the maintenance of the neutrality of the blood which was thus emphasized has led to very extensive and accurate investigations of the mechanisms involved in maintaining the "constancy of the internal environment," a happy phrase coined long ago by Claude Bernard. This work is undoubtedly of much importance, especially for physiology but also for medicine. But I should again like to emphasize that not all disturbances in equilibrium constitute disease. It is only when these disturbances exceed the limits of the factors of safety, as described by Dr. Meltzer, that disease may be said to occur.

Another field of physiology in which great activity has taken place during the present era is that of total metabolism or energy exchange in the body, and this is reflected in the considerable number of lectures dealing with this topic. It is to the great credit of American workers that much knowledge has been gained concerning metabolism under pathological conditions.

Also in the field of nutrition, the discovery has been made that not all proteins are capable of supporting life, but that proteins containing certain specific amino acids are essential. The great advance in the field of nutrition, however, was made by the demonstration that animals can not live and thrive on a diet composed solely of pure protein, fat and carbohydrates combined with inorganic salts and water. Certain other "accessory food factors" were shown to be necessary. When these are lacking, disease supervenes, and this fact has been of value in explaining certain diseases, now called deficiency diseases, such as beriberi, rickets and probably pellagra. Certain analogies have been pointed out between the vitamins and the hormones, indeed the former have been called exogenous hormones. The chemistry of the vitamins and the nature of their action, however, still remain to be studied thoroughly.

Another advance in physiology which is of great significance for medicine consists in the demonstration of the rôle which so-called oxygen carriers play in oxidations within the body, and the demonstration of reactive, ferment-like substances which stimulate oxidation.

In the study of infectious agents and the reactions of the body to parasitic invasion, progress has also been made in many directions. Many of the results obtained, however, have undoubtedly consisted in the application and extension of discoveries which were made during the latter decades of the last century. The important relation of the so-called filterable viruses to human diseases has been demonstrated, and the evidence suggests that this importance is even much greater than is now obvious. The conception of "haptens" and the investigation of the chemical structure of the bacteria, especially in relation to their antigenic properties, the introduction of specific local therapy are all directions of activity which afford promise of wide application. Whether, however, advances in the field of infectious diseases have taken place at the same rate as in the preceding era seems doubtful.

Time will not permit me to speak of the specific contributions of organic chemistry to medicine during this era. Much attention has been given to the constitution of the chemical substances isolated from the tissues and secretions; many more than 200,000 organic substances (mostly synthetic) have now been analyzed and investigated, and much study has also been given to the intermediate stages through which organic compounds pass in their transformation within the animal body. A particular development in this field, namely chemotherapy, has possibly not entirely fulfilled the expectations that were aroused by its great success in supplying a remedy in the treatment of syphilis. Nevertheless, the introduction of this essentially new mode of thought and procedure is of great significance, and it occurred in our era.

Not only have the new developments in physics, especially in the field of light and of electricity, received wide application in the study of biological phenomena, but a new branch of physics, biophysics, has developed. The use of X-rays in diagnosis has been greatly extended. More recently the study of the physiological effects of X-rays and of light of various wave-lengths is being made.

It is obvious that I have been able merely to mention a few of the topics discussed in the Harvey Society lectures. The professional activities of the 220 lecturers indicate to some extent the fields covered. It is rather surprising to find that the largest group of lecturers consisted of clinicians, of whom there were fifty-two; the next largest group was composed of physiologists; the other groups, arranged in order according to size, consisted of biochemists, bacteriologists and parasitologists, pathologists, biologists and geneticists, anatomists and pharmacologists. The list of lecturers has included many of the most distinguished students of medicine; about one fourth of them were from foreign countries.

As one goes over the twenty-four volumes containing the Harvey Society Lectures (the omission of one volume represents one of the losses of war) he can not help experiencing a sense of mystery, almost of awe. Here, beside the wealth which is very evident, there also undoubtedly lie hidden masses of gold, which in many cases are unsuspected, even by the donors. In future years some one will discover and make use of them and reveal riches to us of which we can not dream. On the other hand, these volumes probably conceal deep tragedies. Instead of leaving to their scientific descendants what they believe to be fabulous treasures, some investigators have probably left only ashes to be scattered and lost.

That the number of workers in the science of medicine has tremendously increased during this period and that there is no lack of activity are shown by the wide expansion of the medical literature. In his presidential address before the Thirteenth International Physiological Congress, Professor Krogh stated that in the first year of the century titles were given in the *Zentralblatt für Physiologie* of 3,800 papers; in 1926 there were 18,000. Moreover, that, while in 1901 there were only one hundred papers, or 2½ per cent. of the total, published in America or by American authors, in 1926 there were 3,500 papers, or nearly 20 per cent., from this source. What has occurred in physiology has taken place also in medicine. Professor Krogh also had the temerity to state that in his opinion "too many experiments and observations are being made and published and too little thought bestowed upon them."

During the past twenty-five years there has been a gradual change in the kind of investigation employed in the study of disease and in the methods used. It is only a comparatively few years since Rokitansky expressed the conviction "that pathologic anatomy must be the foundation not only of medical knowledge but also of medical treatment, yes, that it contains everything that there is in medicine of positive knowledge and of foundations for such knowledge." It is evident, however, that during the present century interest in the so-called descriptive sciences, such as anatomy, morphological pathology and possibly organic chemistry, has waned. Indeed, most of the anatomists who have lectured before the Harvey Society have not discussed structure at all. With the anatomists and pathologists experimentation is replacing observation. At the beginning of the century high hopes were entertained for the results that were to follow the chemical analysis of the cells of the body. One of the lecturers has stated that "the action of the cell depends essentially on the nature and quantity of the various substances of which it is made." The same complaint, however, that had been raised against pathological anatomy, namely, that it is concerned only with dead material, began to be raised against organic chemistry. Even the chemists themselves suggest this. One of the most distinguished said in a Harvey Society Lecture, "these descriptive studies [meaning structural chemistry] we may regard as a sort of chemical anatomy of the human body." The biochemists are also becoming experimentalists, employing the methods of chemistry only more or less incidently.

Careful observation and description are no longer fashionable. Even the word "description" causes a certain shrinking, or a shrugging of the shoulders, depending upon who utters it. At the very beginning of the century there occurred a marked tendency to return to the methods of experimental physiology, the kind of activity developed by Magendie and Claude Bernard. But reflections are now being cast even on this kind of investigation. It has been maintained that the entrance of bacteriology on the stage, in the last quarter of the nineteenth century, for a time displaced physiological experimentation. One writer said a few years ago, "With Pasteur and his successors the will was more important than the reflective intellect, and this interlude [the bacteriological] had the effect of narrowing the outlook and rendering medicine less rational." And again, "In default of the physicochemical foundations, during a period when bacteriology was the dominant influence in medical science, and next to it, perhaps, the highly specialized science of organic chemistry, when the prevailing activity was somewhat unintellectual, physiology continued along the old paths."

To my mind this attitude toward bacteriology seems narrow and unjustifiable. However this may be, there is little doubt that during the present century the influences which we have previously noted, especially the attempts to obtain a physicochemical explanation of life itself, and the promulgation of the idea that "physiology is but a special case of the physics of the colloids and the chemistry of the proteids" have led to a very distinct and striking shift in the thought and methods of physiology which is also affecting medicine. To designate this new physiology the term "general physiology" has been employed, or it has been called abstract as contrasted with applied. The field of general physiology, however, does not seem to be very accurately defined, and sometimes the term is used to limit the field to the study of phenomena which are common to all living matter, and again is used to indicate the methods employed in investigation. It may be said, however, that the main problem of general physiology is to describe the properties of living matter in purely physicochemical terms.

All these problems of methodology, however, do not concern students of disease except indirectly. Medicine is indeed a part of biology, but it is only a part. Through the study of disease broad biological generalizations may emerge, as they have in the past. But the immediate problems of the student of disease are not the problems of the biological philosophers or even of the physiologists. The student of disease is trying to describe and to understand the interrelationships of certain special phenomena with which he comes in contact. Even Galileo was content to ask how, not why. In recent years there has seemed at times to be some uncertainty in the minds of those professing the investigation of disease as to exactly what they are studying, possibly a reflection of the confusion in the ranks of the physiologists. It seems to me, as it has seemed to many others, that at least one essential in investigation is that there should be a question asked. If the question relates to disease, then the person who tries to answer it becomes a student of disease, whether he be clinician, physiologist or anatomist. On the other hand, and this is important as regards future advance in medicine, a man is not necessarily a student of disease because he is a doctor of medicine or because he works in a laboratory of medicine, even though he may contribute ever so greatly to science, as, for instance, did Gilbert or Young or Mayer, or be as important in philosophy as was John Locke. Questions concerning disease will most frequently arise in the minds of those coming in contact with disease, though they may arise in the mind of any intelligent person. It seems, however, that the person who most carefully observes and describes the phenomena of disease will ask the "best" questions. The method employed to answer the question or to solve the problem will then have to depend upon a decision as to which method is most appropriate. Whether or not the observer can attempt the solution will finally depend upon whether or not he possesses a sufficient mastery of the appropriate technique to justify his undertaking the task.

In attempting to answer biological questions it seems to be generally conceded that the method which has been found most rewarding is that of hypothesis and test, or as it is called, experimentation. Now in performing an experiment, accurate and careful observation and description are just as important as they are in formulating the question. One wonders, therefore, whether there is not an inherent danger underlying the present tendency to scorn and belittle observation, and whether the possibilities of clinical medicine, and anatomy and morphological pathology, and organic chemistry were all exhausted in the nineteenth century. The experience of the past twenty-five years seems to indicate that this kind of investigation still brings its rewards.

In description, various kinds of yardsticks may be employed. For describing some phenomena extremely accurate quantitative measurements, even formal mathematical treatment of the results, in order to reveal hidden quantitative relationships, are appropriate. For describing other phenomena such measurements are not only unnecessary but quite unsuitable. In recent years there has been a tendency to assume that great accuracy in measurement and the use of higher mathematics in the study of the problems of physiology and disease at once endow the investigation with a sacerdotal dignity. This is also true of the use of the methods of chemistry, physics and physical chemistry. One of the great advances made in the present century consists in the fact that now many students of medicine are trained in these sciences and have more or less mastery of their techniques. But discrimination is necessary in their employment when attempting to describe disease processes. The student of disease should be certain that he is trying to learn about disease and not merely exercising his technical skill. One needs only to recall some of the absurdities and futilities of the iatro-mathematical and iatro-physical and iatro-chemical schools of the seventeenth century to realize the dangers inherent in this attitude of mind. Sanctorius is said to have spent forty years of his life in weighing himself three or four times a day.

Furthermore, there has grown up a certain sanctity about the word experimentation which seems to me to be unjustifiable. Experiments are of two kinds: first, the true experiment carried out to test a hypothesis; and second, the more or less random procedure undertaken to see what may happen. These latter experiments, made without hypothesis, can have only one purpose, and that is, to afford opportunity for observation. As Claude Bernard pointed out, such experiments are at times valuable since, in making the observations, hypotheses are suggested, and these can then be verified or disproved by true experimentation. But the student of medicine has little need for such groping for material. He is daily surrounded by phenomena which are stimulating beyond measure if he but have eyes to see.

It has been assumed that during the present era medicine has become more rational. The introduction of rationalization into medicine is of extreme importance, just as is its employment in all scientific activities. John Hunter's advice, "Don't think, try," is all very well in the meaning intended, but the injunction must not be taken too literally. Think first, then try, may be a better maxim. And on what one thinks about will depend what he will do. But the question arises whether the present trend in medical investigation really fosters thinking. Modern medical education has supplied an army of trained technicians. Are they all asking questions concerning disease and attempting to solve them, or are many of them only interested in desultory and fragmentary employment of the techniques they have acquired, having faith in the Baconian concept, that if a sufficient number of observations and experiments are made, the connections will appear and general truths automatically evolve? Such an attitude of mind seems to belong in the seventeenth century, not the twentieth.

What I have said does not mean that the student of disease must always be attempting a direct approach to the solution of his problem. Usually it is necessary to start far away from this goal and often to take a circuitous path, but he should always have the goal in mind, otherwise he really belongs in some other field of scientific endeavor. It has recently been said that "for the first time mathematics, physics, chemistry and physical chemistry, as aids to physiology, have passed into the hospital." I cannot but feel that the phrase "as aids to physiology" was introduced by the writer inadvertently. But it is possibly true and may be of some significance.

One wonders whether if the student of disease did but observe, and then describe in language appropriate to the phenomena observed, following Daniel Drake's advice "to write much and publish little," and then if he would think, and think until it hurts, and make experiments only when he has evolved a hypothesis that interests and satisfies him, performing a sufficient number of experiments and employing a technique appropriate for the particular purpose, but publishing only when he had satisfied himself that a conclusion had been reached, even if negative, not only might the bewildering number of publications be reduced, but the increase in knowledge be materially accelerated. For as Professor Whitehead says, "The growth of a science is not in bulk but in ideas." Perhaps this is heretical doctrine, and no one realizes its dangers better than I. During the past twenty-five years it has been important, at least in this country, that young men be stimulated to investigate. And nothing so urges a beginner to further effort as to witness the birth of his labors. Moreover, there is nothing so much feared at present as inactivity. But is it not time for this naïve attitude to be dropped?

May there not be a lesson for us in the history of physics during the present era? A recent history of science states that "at the end of the last century, it seemed that all that remained for the physicist to do was to make measurements to an increasing order of accuracy." It goes on to describe how physics then suddenly took on new life. New concepts were born. The atom was resolved into more minute corpuscles and these in turn into electrical units. The old concept of mass was overthrown and a new one took its place. Radioactivity was interpreted in terms of atomic disintegration. The quantum theory of radiation superseded the wave theory, or at least was added to it. Space and time became no longer absolute. A particle became a mere series of events in space-time. Physicists have become less certain than they were at the beginning of the century.

Biology and physiology and medicine too have come to have some misgivings, but so far these doubts have not been very coherent or articulate. The speculations of men like Whitehead, who emphasize the relation of the organism to the environment, the development of the theory of emergent evolution, which Jennings calls "the Declaration of Independence for the biologist," the concept of biology as an independent science by Haldane and his followers, have all exerted an influence in stimulating the study of the organism as a whole and not merely as an agglomeration of parts. Nevertheless, while in the study of disease it is not necessary finally to accept any theory of the ultimate nature of life, it is difficult to conceive of any successful method of procedure which in all its steps does not assume a physicochemical basis for living things. This does not mean, however, that it is necessary to make graven images of chemistry and physics. At any rate, the question may be raised whether in the study of disease it is always necessary to resolve the organism into electrons, or whether advances can not be made also by studying the organism itself. Certainly the history of the past twenty-five years, as of all preceding periods within the era of modern science, seems to answer this question in the affirmative.

Looking backward, one wonders whether it would have been possible for any one to foretell the directions in which the greatest progress would be made in medicine during the quarter century just passed. Probably the greatest promise seemed to lie in fields other than those which have apparently yielded the most important results. It would therefore be hazardous to attempt to predict the future. But of one thing we may be sure, the foundations on which the future is to be built have been rendered more solid, more substantial; the builders who are to undertake the new tasks are enormously increased in number; they are better equipped; they have a wider knowledge of the fundamental sciences; they have acquired greater technical skill in experimentation; they have at their disposal greatly increased facilities. This insures a continuation of progress. There is some evidence too that the workers are trained to think more logically and rationally than their predecessors.

But after all, probably what is needed most in medicine is not method but men, and not merely photographers but artists. Whether the coming era will be a golden age depends on whether in medicine "there shall be minds acting upon thoughts so as to color them with their own light, and composing from these thoughts, as from elements, other thoughts, each containing within itself the principle of its own integrity." For these geniuses we are dependent upon the gods.

THE HARVEY SOCIETY[1]

By Professor GRAHAM LUSK
CORNELL UNIVERSITY MEDICAL COLLEGE

President Hartwell, of the Academy of Medicine,
President Robinson, of the Harvey Society,
Ladies and Gentlemen:

THE story of the birth of the Harvey Society is a simple one. I was dining in the old Lusk home at 47 East 34 Street and sat next to Mrs. Anna Bowman Dodd. You will remember that it was she who wrote many years ago "Three Normandy Inns." The greater part of her life she lived in France; in Paris in the winter, and in a beautiful home at Honfleur on the Normandy coast in the summer. She has recently passed away at the age of about eighty. It gave her pleasure to the end to be told that she was the real founder of the Harvey Society. At the dinner to which I refer she said that during the winter she had attended a course of splendid lectures at the Sorbonne upon the subject of Roman law expounded by a brilliant Frenchman. It occurred to me that if an educated American woman past middle life could be thrilled by lectures on Roman law, there must be physicians in New York who would be interested in hearing lectures on scientific subjects as expounded by scientific workers themselves. There was only one man with whom to go into conference on this subject and that was Dr. Samuel J. Meltzer. Meltzer had already used the library of my home at 11 (now 9 and rebuilt) East 74 Street, for in it a few years before, he had founded the Society for Experimental Biology and Medicine, sometimes for the sake of abbreviation affectionately known as "The Meltzer Verein." This was to be a society of scientific workers, and is to-day a notable feature of the Academy of Medicine. In response to a telephone call Meltzer came to see me immediately and, sitting together on a sofa, I outlined my plan. He said the idea was impossible; New York was a city devoid of scientific interests. The Academy of Medicine was not a scientific body and had no interest in scientific medicine. No one would come to the meetings and it would be futile to start such a movement.

A few days after this Meltzer called me on the telephone and said, "You must call that meeting at your home." I replied, "But, Dr. Meltzer, you said the plan was impossible." "Ah, but I have changed my mind."

So it came about that there met at my home on the anniversary of Harvey's birth, April 1, 1905, the following group of men: Meltzer, W. H. Park, E. K. Dunham, Ewing, Lee, Herter, Flexner, Wallace, T. C. Janeway, Levene, Opie, Abel, of Baltimore, and Lusk. I outlined the plan. Every one objected, using the same arguments which Meltzer had originally used against it and which Meltzer now convincingly answered. His final words were, "Never mind if no one comes except ourselves. We will wear our dress clothes, sit in the front row and show the speaker that we appreciate him."

We drafted as simple a constitution as possible. The society was described as founded for the diffusion of knowledge of the medical sciences. The active members were to be laboratory workers who were to choose a president and other officers annually. The lectures were to be on scientific subjects by masters who had worked upon the themes they presented. The associate members were to be practicing physicians who represented the best types in the city. This list was originally selected by Meltzer, Dana, then president of the academy, and by Abraham Jacobi. Meltzer remarked, " I wish to have this list so select that when a man comes to die it shall be said of him, 'He was a member of the Harvey Society.' " Scarcely any one who was invited declined.

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[1] Address delivered at the twenty-fifth anniversary of the Harvey Society, May 15, 1930.

The Society of Biological Chemists, the soul of which was undergoing transmigration into the body of the Meltzer Verein, bequeathed to the Harvey Society $100, the total sum of cash in its treasury. This was the first and last donation ever given to the society.

Originally the lecturers received no fee, but their traveling expenses were defrayed and they were entertained while in New York.

The Harvey Society seemed an especially appropriate name, since Harvey, among other great contributions to the Royal College of Physicians in London, had established an annual oration in which the benefactors of the college were to be commemorated and the fellows and members of the college were to be exhorted to search out and study the secrets of nature by way of experiment and to continue in mutual love and affection among themselves.

The first lecture of the Harvey Society was given in German by Professor Hans Horst Meyer, of Vienna. At this lecture the society was formally presented to the public by Dr. C. A. Dana, then president of the Academy of Medicine, and he declared it to be under the patronage of the academy. The society owes much to Dr. Dana. The second lecture was given by Dr. Carl von Noorden, and there was standing room only in the hall. The anxious concern over the success or failure of the undertaking came to an end.

The society was made up of a group of young men. I remember giving a dinner of thirty to Professor Max Rubner, of Berlin, nearly twenty years ago, and he, surveying the table, said to me, "You have no old men in America." As far as our scientific group was concerned, this was then true. Scientific medicine in New York stood at the beginning of time.

We sought to develop a forum where young workers in experimental medicine could unfold their ideas for the benefit of the medical profession. The influence of the society was not confined to New York City. Thus, when Woodyatt, of Chicago, was invited to give a lecture before the Harvey Society, he told me that his associates in Chicago began to say to each other that he must amount to something if a group of scientific men in New York thought his work to be of such significance that they asked him to address them.

The solemnity of the society was once disturbed on the occasion of a lecture given on February 15, 1913, by Theodore Janeway on the subject of "Nephritic Hypertension: Clinical and Experimental Studies." A few days before the lecture some of the members of the society received the following postal card printed in exactly the same form as the regular notices:

THE HARVEY SOCIETY

A Society for the Diffusion of
Somnolence by Medical Scientists

The Seventh Lecture will be delivered on Saturday, February 15th at 8: 30 p.m., at the New York Academy of Medicine, by Professor Theodore C. Janeway, of Columbia University.

Subject:
"HYPNOTIC HYPERATTENTION: CYNICAL AND EXPERIMENTAL STUDIES"

Professor Janeway was one of the most successful cures made by the society. Testimonials from Dr. W. C. Lusk and others furnished on request.

1 mile 1 — 1 hour 1
of dazzling charts — without an open eye
Sufferers from Insomnia come!
Let us cure you.

Meltzer came to see me in hot haste. Some enemy of Janeway had done this, who should be apprehended and punished. It developed that Janeway, who was fond of a good joke, had done it himself.

Dr. Cole has told you of the developments of science during the past twenty-five years. The development of science during the next twenty-five years is entrusted to many who are here to-night. Those of us who have worked in the past transmit this heritage to those of you who are to carry on in the future the ideals represented by the Harvey Society. We do this with the firm conviction that during the next twenty-five years scientific medicine will advance as rapidly as it has done in the past quarter of a century.

We are groping in the dark to find the secret of the production of scientific men. They are certainly not produced by the administration of any known patent medicine. Lavoisier, Gay-Lussac, Liebig, Johannes Müller and Pasteur were not developed according to formulas. Ostwald, in his "Grosse Männer," says that the facilities granted to Liebig at Giessen gave him water to swim in. Some of our good scientific men have not been given water enough even to float. Others have been given so much that they have been drowned. The great problem of to-day is to seek out brilliant young men and establish them so that they may accomplish good work, and may also feel free from financial worries which so often beset them. Such a policy will tend to produce distinguished scientific men in greater number and will give a greater choice of Harvey Society lecturers than ever before.

I rejoice to sit near my life-long friend and dear colleague, Dr. Hartwell, to share an honorable place with the president and the ex-presidents of the Harvey Society, who have done so much to promote medical science in New York City, and to feel that Dr. Welch and Dr. Cushing have generously given their distinguished presence at this birthday party of the Harvey Society.

SCIENTIFIC EVENTS

NATIONAL MONUMENTS IN ARIZONA

President Hoover has signed the act of Congress authorizing the exchange of privately owned lands in the Petrified Forest National Monument for government-owned lands outside the reservation in Navajo and Apache Counties, Arizona.

The Petrified Forest National Monument contains a total acreage of 25,908.4 acres. Of this 12,792.74 acres are in private ownership, representing original railroad land grants and occupying alternate sections throughout the monument. Such a situation precluded effective administration and also made impossible the construction of an adequate road and trail system to make available to the visiting public the principal features of the monument, since the roads and trails would unavoidably have to pass fifty per cent. over private lands and expenditure of government funds could not be authorized under these conditions. It is to obviate these difficulties that the exchange of lands as outlined above was authorized.

The New Mexico and Arizona Land Company, present owner of the alternate sections, has signified its willingness to make the desired exchange which is solely in the interest of government administration of the monument.

The trees of the fossil forest are not standing, but lie scattered over the ground in great profusion. They did not grow where they lie, but were carried from a long distance to this region by flood waters, became waterlogged and finally sank to the bottom of the great inland sea which once covered the region. Here they lay for countless ages, slowly being covered with silt and sand, and gradually becoming fossilized. Thousands, perhaps millions, of years later the submerged logs, now stone, were through some upheaval brought to the surface again and uncovered. It is estimated that the trees were green and growing about 20,000,000 years ago.

The petrified trees of this area are more highly colored than in any similar area, and there are more of them.

Last year more than 69,000 people visited the Petrified Forest National Monument.

The new Sunset Crater National Monument is located within the Coconino National Forest in Arizona, and will be administered by the Forest Service. The area set aside for the monument totals 3,040 acres, and includes Sunset Mountain with its extinct crater and the ice caves at the foot. These have been points of interest visited by many people each season for the last 20 years.

THE DUDLEY HERBARIUM

The Dudley Herbarium has begun a botanical survey of Lower California. This work is under the direct charge of Dr. Ira L. Wiggins, and has been made possible through the generosity of Mr. H. C. Dudley, of Duluth, Minnesota, and Mr. E. G. Dudley, of Exeter, California.

Professor Wiggins has made two collecting trips into Lower California during the past nine months. The first extended from September 1 to 20, 1929, the itinerary leading through the northernmost part of the peninsula. The route followed the coast from Tia Juana to Ensenada, circled eastward through the Valle San Rafael, crossed the southern end of the Mesa del Pinal and reentered the United States at Mexicali. A more extended expedition occupied the latter part of February and the month of March of this year. During this time field observations and collections were made from the border southward to the desert region in the vicinity of Chapala, about 350 miles from Tia Juana. The winter had been very dry so collecting was rather poor, but a fair amount of interesting material was obtained. Extensive field notes on the distribution and habitat of several interesting species endemic to the central part of the Lower California peninsula were taken and numerous photographs made. An account of this phase of the work will be published later.

A program to cover a period of several years calls for further extensive field work and collecting throughout the entire peninsula and will ultimately lead to the publication of a comprehensive floristic study of the area. Such trips are to be made at various seasons of the year and to little known or unexplored areas in order to fill gaps in the collections of earlier workers.

NATIONAL RESEARCH FELLOWSHIPS IN THE BIOLOGICAL SCIENCES

The second and final meeting of the Board of National Research Fellowships in the Biological Sciences for the award of 1930–31 appointments was held in Washington on May 1 and 2. In addition to the ten reappointments and twenty-four new appointments voted at the February meeting, ten further reappointments and twenty-two first appointments were made at the meeting in May, as follows:

REAPPOINTMENTS

For domestic study

Norval Burk—biochemistry
C. R. Burnham—agriculture
F. M. Carpenter—zoology
Leonard B. Clark—zoology
Myron Gordon—zoology
Harry Grundfest—zoology
David A. Kribs—botany
Norman R. F. Maier—psychology

For study abroad

Lester G. Barth—zoology
Philip R. White—botany

NEW APPOINTMENTS

For domestic study

W. M. Banfield—agriculture
Ralph L. Beals—anthropology
P. J. Daughenbaugh—biochemistry
Robert K. Enders—zoology
Dwight L. Espe—agriculture
Paul E. Fields—psychology
J. W. Gillespie—botany
J. P. Greenstein—biochemistry
E. Harold Hinman—zoology
A. W. Kozelka—zoology
Chester E. Leese—zoology
Roger B. Loucks—psychology
Helen Mar Miller—zoology
Harold P. Morris—agriculture
Elsa R. Orent—biochemistry
Hortense Powdermaker—anthropology
K. C. Pratt—psychology
Alexander F. Skutch—botany
Otis C. Trimble—psychology
C. W. Watson—agriculture
G. R. Wendt—psychology
Samuel Yochelson—psychology

For study abroad

L. M. Bertholf—agriculture
David B. Hand—biochemistry
J. I. Hardy—agriculture
Ancel B. Keys—zoology
George Kreezer—psychology
Floyd L. Ruch—psychology

In accordance with the plan of rotation in membership of the board the terms of the following members expire on June 30 of this year: T. H. Morgan, zoology; W. J. V. Osterhout, botany, and C. E. Seashore, psychology. To complete the membership in these three fields, the National Research Council has appointed H. S. Jennings, of the Johns Hopkins University, for zoology; Dr. Harry M. Johnson, of the Mellon Institute for Industrial Research, Pittsburgh, for psychology, and Dr. W. J. Robbins, of the University of Missouri, for botany. Also, in order that anthropology may have two representatives on the board, Dr. Fay-Cooper Cole, of the University of Chicago, has been asked to serve for the fiscal year, 1930-31.

Meetings for 1931-32 awards will be held approximately early in February and either in April or May of next year. More definite announcement concerning these will be made in SCIENCE in the fall. Information and application forms may be obtained at any time from the secretary, Board of National Research Fellowships in the Biological Sciences, National Research Council, Washington, D. C.

FRANK R. LILLIE, *Chairman*
BOARD OF NATIONAL RESEARCH FELLOWSHIPS
IN THE BIOLOGICAL SCIENCES

THE ANNUAL MEETING OF THE ROYAL SOCIETY OF CANADA

ON May 20, 21 and 22 the Canadian Royal Society met at McGill University. The presidential address was given by Professor A. S. Eve, on the evening of the twentieth, his subject being "The Universe as a Whole." (SCIENCE, May 23, 1930.) At the same session he presented the three gold medals of the society. The Flavelle Medal was awarded to Dr. A. B. Macallum, F.R.S., emeritus professor of biochemistry at McGill University, for his pioneer researches in micro-biochemistry; the Lorne Pierce Medal for outstanding contributions to literature, to Sir Andrew Macphail, professor of the history of medicine at McGill University, and the Tyrrell Medal for research in Canadian history to Dr. Adam Shortt, of Ottawa. At the final session the Honorable Vincent Massey, Canadian minister to the United States, gave the popular lecture on "Art and Nationality in Canada." In Sections I and II (respectively, French and English Literature and History) thirty-six papers were read. In Section III (Mathematics, Physics and Chemistry) ninety-nine papers were communicated, in Section IV (Geological Sciences) 13 papers, and in Section V (Biological and Medical Sciences) 59 papers.

A very interesting event was the delivering of an address by radio by Sir Ernest Rutherford, president of the Royal Society of London, speaking from his English home to the fellows gathered in the Moyse Hall of McGill University. The whole of the address, with the exception of the few opening sentences, was clearly heard by a large audience, as was also the telephone conversation that followed, between Sir Ernest at the one end, and Professor Eve, Sir Arthur Currie and Sir Robert Falconer in turn at the other. Only ten years previously it had been considered a remarkable event when, also under the direction of Professor Eve, an artist sang at Montreal to an audience of the Royal Society at Ottawa, 110 miles away, and the reception over this short distance was much less perfect.

BRITISH HONORS

FROM the list of honors conferred on King George's birthday, *Nature* selects the following names of scientific workers and others associated with scientific activities: *Baron:* The Right Hon. Noel Edward Buxton, minister of agriculture and fisheries. *Baronets:* Mr. Basil Mott, past president of the Institution of Civil Engineers, and Mr. F. H. Royce, founder, director and chief engineer of Rolls Royce, Limited. *Order of Merit:* Professor S. Alexander, in recognition of his eminent position as a British philosopher and for his services as a writer and teacher. *Knights:* Dr. E. Brown, secretary of the National Poultry Council of England and Wales; Major T. H. Crozier, chief inspector of explosives, Home Office; Professor A. S. Eddington, Plumian professor of astronomy in the University of Cambridge; Professor Leonard E. Hill, director of the department of applied physiology, National Institute of Medical Research; Dr. G. A. K. Marshall, director of the Imperial Bureau of Entomology; Professor J. Arthur Thomson, Regius professor of natural history in the University of Aberdeen; Mr. H. W. A. Watson, lately chief conservator of forests, Burma; Mr. H. Wright, chairman of the executive committee of the governing body, Imperial College of Science and Technology, South Kensington. *K.B.E.:* Sir Philip Hartog, chairman of the education committee, Indian Statutory Commission. *C.B.E.:* Dr. E. W. Smith, honorary technical adviser to the area gas supply committee, Board of Trade. *O.B.E.:* Mr. T. P. W. Barty, lecturer in civil engineering, Gordon College, Khartoum, and municipal engineer, Khartoum; Mr. J. A. B. Horsley, electrical inspector of mines, Board of Trade; Professor W. M. Roberts, professor of mathematics, Royal Military Academy, Woolwich; Dr. F. B. Young, principal scientific officer, Admiralty Research Laboratory. *M.B.E.:* Mr. J. Haworth, general manager of the sewage disposal department and chief chemist and water examiner, Sheffield Corporation; Mr. H. W. Jack, economic botanist, Agricultural Department, Straits Settlements and Federated Malay States; Mr. H. G. D. Rooke, lately chief locust officer, Ministry of Irrigation and Agriculture, Iraq; Dr. A. Winstanley, junior inspector of mines, Board of Trade. *C.I.E.:* Mr. F. F. R. Channer, lately chief conservator of forests, United Provinces; Lieutenant-Colonel H. R. Dutton, lately principal, Prince of Wales' Medical College, Patna, and superintendent of the Patna Medical College Hospital, Bihar and Orissa; Mr. L. Mason, lately chief forest officer, Andamans; Mr. R. R. Simpson, chief inspector of mines in India. *C.V.O.:* Mr. Evelyn C. Shaw, secretary since 1910 to the Royal Commissioners of the Exhibition of 1851. *I.S.O.:* Mr. D. Keiller, head laboratory assistant, Imperial Institute of Veterinary Research, Muktesar, United Provinces.

SCIENTIFIC NOTES AND NEWS

YALE UNIVERSITY conferred on June 18 the doctorate of science on Dr. Edwin Grant Conklin, professor of zoology at Princeton University, and on Professor Charles Schuchert, professor of paleontology and historical geology at Yale University and curator emeritus of paleontology in the Peabody Museum.

THE doctorate of science was conferred at the commencement of the University of Pennsylvania on Alexander von Lichtenberg, professor of urology at the University of Berlin, and on Edward E. Allen, director of the Perkins Institution, Watertown, Massachusetts.

THE degree of doctor of laws has been conferred by the University of Indiana on Dr. V. M. Slipher and Dr. C. O. Lampland, of the Lowell Observatory at Flagstaff, Arizona.

DR. CHARLES SHEARD, of the Mayo Foundation at Rochester, Minnesota, received the honorary degree of doctor of science at the commencement exercises of St. Lawrence University.

MR. ORVILLE WRIGHT, Dayton, Ohio, co-inventor of the airplane, was awarded the honorary degree of doctor of science by the Ohio State University at the annual commencement.

AT the commencement exercises on June 10, the University of Arkansas conferred the degree of doctor of laws on Dr. Charles W. Webb, chief surgeon of the Clifton Springs, New York, Sanitarium and Hospital and president of the New York State Society of Surgeons.

DR. CHAS. B. DAVENPORT, of the Carnegie Institution of Washington, has been elected an honorary member of the Vienna Anthropological Society.

THE Lucien Howe medal was presented to Dr. J. N. Adams, of Brooklyn, for distinguished research in the field of blind areas of the eye at the commencement exercises of the University of Buffalo.

WORCESTER POLYTECHNIC INSTITUTE, at its commencement exercises on June 13, conferred the honorary degree of doctor of engineering on four of its graduates and upon the commencement speaker, Brigadier General Robert Irwin Rees, assistant vice-president of the American Telephone and Telegraph Company. The alumni who received the degrees are Harry Phillips Davis, vice-president of the Westinghouse Electric and Manufacturing Company; Henry Jones Fuller, partner in the Wall Street banking house of Alfred and Co.; Samuel Sumner Edmands, director of the School of Science and Technology at the Pratt Institute, Brooklyn, and Harrison P. Eddy, senior member of Metcalf and Eddy, consulting engineers, Boston.

REAR ADMIRAL RICHARD E. BYRD will receive from President Hoover on June 20 a special gold medal of the National Geographic Society awarded for his distinguished contributions to the knowledge of Antarctica. On this occasion Admiral Byrd will make the first report on the research work of the expedition, and the motion pictures will have their first showing. The medal, especially designed, as Admiral Byrd already possesses the society's Hubbard Gold Medal, bears the inscription: "Richard Evelyn Byrd, rear admiral, U. S. N. He made distinguished contributions to knowledge of Antarctica, and was first to reach the geographical South Pole by air, November 29, 1929."

THE American Geographical Society has awarded the Charles P. Daly Medal for 1930 to Lauge Koch, of Copenhagen, for his explorations in northern and eastern Greenland and his interpretations of the physical geography of that country. The David Livingstone Centenary Medal for 1930 has been awarded to José M. Sobral, director-general of the Argentine Bureau of Mines and Geology. Under Dr. Sobral's administration his bureau has for many years been productively engaged in a program of mapping and geographical and geological studies, especially in the Andean section of the country.

THE Royal Aeronautical Society, London, held a dinner on May 30 after the delivery of the eighteenth Wilbur Wright Memorial Lecture by Mr. H. R. Ricardo. The presentation of a silver box suitably inscribed was made to Sir Richard Glazebrook to commemorate the twenty-first anniversary of the founding of the advisory committee for aeronautics, Sir Richard Glazebrook having been chairman of that committee since its foundation in 1909. Lieutenant-Colonel J. T. C. Moore-Brabazon was also presented with a small gift from the president and fellow-members of the council inscribed "To commemorate the twenty-first anniversary of his flight on the second of May, 1909—the first flight in a power-driven aeroplane piloted by a British subject in the British Isles." At the lecture which preceded the dinner the silver medal of the Royal Aeronautical Society was presented to Mr. F. H. Royce for his conspicuous work in the design and development of aircraft engines.

THE committee on scientific research of the American Medical Association has made a grant of $1,500 to Dr. Robert Hegner, of the School of Hygiene and Public Health of the Johns Hopkins University, to aid him and his colleagues in the study of the host-parasite relations between man and his parasitic protozoa.

PROFESSOR JOHN C. SLATER, of Harvard University, is to be the new head of the department of physics at the Massachusetts Institute of Technology, succeeding Professor Charles L. Norton, who will in the future devote his full time to the direction of the division of industrial cooperation and research. This plan has the complete approval of the Harvard physicists as opening the way to increased cooperation between the physics departments of the two institutions. A conference of the Harvard physicists with Professor Slater and President-elect Compton was recently held, at which preliminary plans were made for such coordinated efforts. A new laboratory for research in physics and chemistry at the institute will probably be ready within a year and a half.

DR. JAMES ANGUS DOULL, of the School of Hygiene and Public Health of the Johns Hopkins University, has been appointed professor of hygiene and public health at the School of Medicine of Western Reserve University, to succeed Dr. Roger G. Perkins, who is retiring at the end of the present year. Other appointments at the School of Medicine are: Dr. Donald E. Gregg, of the University of Rochester, instructor in physiology; Dr. H. A. Blair, of Princeton University, instructor in biophysics, and Dr. Ramon F. Hanzal, instructor in pathological chemistry. Dr. James W. Mull has been promoted from research fellow in biochemistry to be senior instructor in charge of biochemical research in obstetrics.

DR. ALFRED C. REDFIELD has been advanced to a professorship of physiology in the Harvard Medical School.

DR. A. LINCOLN DRYDEN, JR., has been appointed associate in ecology at Bryn Mawr College for the coming year.

MR. DAVID B. REGER, of Morgantown, West Virginia, has resigned his position as associate geologist of the West Virginia Geological Survey, effective August 31.

Dr. J. J. Willaman, chief of the chemistry division of the New York Agricultural Experiment Station, will resign on October 1 to accept a position as biochemist with the Rohm and Haas Company of Philadelphia.

Dr. E. V. Abbott has resigned as plant pathologist of the Agricultural Experiment Station, Lima, Peru, to accept an appointment with the Bureau of Plant Industry of the U. S. Department of Agriculture. Mr. Ralph H. Gray has resigned as horticulturist of the station, and is returning to the United States to enter commercial work.

Dr. George Allan Works has resigned from the presidency of the Connecticut Agricultural College at Storrs and is returning to the University of Chicago. It is reported in an Associated Press dispatch that he was dissatisfied with the attitude of the state toward the college, as his policies called for the development of the academic aspects of the institution, while the state sought to develop it as an agricultural college.

At the anniversary general meeting of the Royal Geographical Society, to be held on June 23, Colonel Sir Charles Close will resign the presidency of the society, and the council proposes as his successor Admiral Sir William Goodenough. It is also proposed to add Dr. Hamilton Rice to the list of vice-presidents. Brigadier Jack, one of the honorary secretaries, is to give up that post, and it is proposed to elect in his stead Dr. T. G. Longstaff.

Dr. George K. Burgess, director of the Bureau of Standards, was elected president of the National Conference on Weights and Measures at the concluding session of the twenty-third national conference recently held in Washington, D. C. Other officers elected were: Howard S. Jarrett, of West Virginia, *first vice-president;* Albert B. Smith, of Pennsylvania, *second vice-president;* F. S. Koolbrook, of the Bureau of Standards, *secretary,* and George F. Austin, Jr., of Detroit, *treasurer.*

Dr. W. G. Crockett, professor of pharmacy in the school of pharmacy of the Medical College of Virginia, has been elected chairman of the Virginia section of the American Chemical Society and a member of the revision committee of the United States Pharmacopoeia.

Dean Charles W. Johnson and Professor Henry A. Langenhan, of the University of Washington's College of Pharmacy, have been named to the U. S. Pharmacopoeial Revision Committee. Dean Johnson's term will be for ten years. At the recent convention of the American Association of Colleges of Pharmacy, held in Baltimore, Professor Langenhan was elected vice-president. Dean Johnson was president of the group in 1927.

Dr. W. S. Leathers, professor of preventive medicine and dean of the Vanderbilt Medical School, has been elected a member of the board of scientific directors of the International Health Division of the Rockefeller Foundation.

Miss Alice C. Evans and Dr. Sara E. Branham, bacteriologists in the National Institute of Health (The Hygienic Laboratory), have been appointed delegates from the U. S. Public Health Service to the first International Microbiological Congress which meets in Paris from July 20 to 25.

Mr. J. H. Fleming, of Toronto, honorary curator of birds in the National Museum of Canada, and vice-president of the American Ornithologists' Union, attended the recent International Ornithological Congress at Amsterdam, as representative of the National Museum and the Government of Canada. Mr. Fleming is returning from Europe on July 1.

Dr. C. E. Hellmayr, associate curator of birds at the Field Museum, has gone to Europe on an ornithological research mission for the Field Museum. He has taken a number of rare bird specimens collected by the Crane Pacific Expedition, the Marshall Field South American Expedition, and others for comparison with type specimens in museums of Great Britain, France, Germany and other countries.

Mr. J. R. Van Pelt, curator in charge of the division of geology and the mineral industries in the Chicago Museum of Science and Industry, returned from Europe recently following a two months' study of European technical museums. The new seven million dollar building for the museum is now in course of construction, and much of Mr. Van Pelt's time was devoted to the study of recent developments in museum buildings.

Mr. William R. Barbour, forester of the Tropical Plant Research Foundation, has returned to Washington after spending six months in Venezuela, Colombia and Nicaragua, making a survey of the timber resources of those countries. This year's work completes a three-year study of the Caribbean regions, made by the Tropical Plant Research Foundation with the cooperation of the Charles Lathrop Pack Forestry Trust, to determine the location and relative abundance of the woods of the tropics which might serve to replace or supplement hardwoods of the temperate zone. In connection with this survey, logs of fifteen species of Venezuelan woods have been sent to the University of Michigan to be given thorough and practical tests to determine their suitability for use as substitutes for domestic hardwoods.

PROFESSOR HOWARD E. SIMPSON, of the department of geology of the University of North Dakota, delivered the address at the annual dinner of the North Dakota Academy of Science at Fargo on May 9, the State College Chapter of the American Association of University Professors acting as hosts. The subject of the address was "The Geological Story of the La Brea Tar Pits Retold."

THE George Alexander Gibson Memorial Lecture was delivered at the Royal College of Physicians of Edinburgh on May 27 and 28 by Dr. William Sydney Thayer, emeritus professor of medicine of the Johns Hopkins University. Professor Thayer spoke on "Endocarditis."

THE Halley Lecture was delivered at Oxford on May 30 by Professor A. S. Eddington, who took as his subject "The Rotation of the Galaxy."

THE New Hampshire Academy of Science met at Henniker, New Hampshire, for its annual meeting on June 6 and 7. Officers for the year were elected as follows: *President,* Dr. Charles H. Dolloff, superintendent of the New Hampshire State Hospital: *vice-president,* Professor James W. Goldthwait, Dartmouth College; *secretary-treasurer,* Professor George W. White, University of New Hampshire; *chairman Publication Committee,* Mr. Frank H. Foster, Claremont, New Hampshire. The address of the retiring president, Mr. G. L. Cave, of the Brown Company, was on "Robert Calef, An Early American Scientist."

THE Tenth International Conference of Chemistry will take place at Liège on September 14 to 20. The following agencies, committees and commissions will meet in the course of this conference: Council of the Union; General Assembly of the Union; Committee on Chemical Elements; Committee for the Reform of Inorganic Chemical Nomenclature; Committee for the Reform of Organic Chemical Nomenclature; Committee for the Reform of Biological Chemical Nomenclature; International Bureau of Physico-Chemical Standards; Committee on Thermo-Chemical Data; Committee on Tables of Constants, and the Committee on Physico-Chemical Symbols.

THE Royal College of Physicians of Edinburgh proposes to celebrate on St. Andrew's Day, 1931, the two hundred and fiftieth anniversary of its foundation.

THE University of Chicago has received anonymous gifts amounting to about $2,000,000 to build new laboratories for the departments of bacteriology and anatomy.

THE Medical College of Virginia, Richmond, has received grants of $120,000, $40,000 from the Julius Rosenwald Fund and $80,000 from the General Education Board for the construction of a dormitory and educational unit for the school of nursing of the St. Philip Hospital. This is an institution for Negroes, owned and operated by the college.

THE returns of the British Registrar-General for the first quarter of 1930 show that the birth-rate was 16.2 per 1,000 population, the death-rate was 13.5 per 1,000, while the infant death-rate was 77 per 1,000 registered live births. The birth-rate is the lowest recorded in any first quarter since the establishment of civil registration, except that of the first quarter of 1919, when, owing to the war, the rate fell to 15.7 per 1,000. The infant death-rate is the lowest ever recorded in any first quarter, being 16 per 1,000 below the average of the 10 preceding first quarters and 3 per 1,000 below that of the first quarter of 1928, the lowest reached in any earlier first quarter. The natural increase of population by excess of births over deaths was 26,725, as against a natural decrease in 1929 of 44,112. This difference is explained by the fact that influenza was not epidemic in the early months of this year.

THE purchase of a 32,555-acre tract in South Carolina and of 5,180 acres in Colorado as migratory bird refuges has been approved by the Migratory Bird Conservation Commission, acting on the recommendation of the Bureau of Biological Survey of the Department of Agriculture. These areas will constitute the first bird refuges to be acquired by purchase under the migratory bird conservation act of Feb. 18, 1929, by which Congress authorized the expenditure over a 10-year period of nearly $8,000,000 for surveys and acquisition of lands for migratory bird refuges. The actual acquisition of the two areas will proceed immediately after July 1, 1930, when funds appropriated under the act become available to the department. The average price for these lands authorized by the commission is $1.13 an acre. The unit to be acquired in South Carolina is in the Cape Romain region, Charleston County, on the Atlantic seaboard; the other is in the San Luis Lake region, Alamosa County, Colo. Specialists of the Biological Survey have examined and appraised both areas from the standpoint of food resources for wild fowl and from other angles and have found them to be ideal refuges.

UNDER a special appropriation of $100,000 provided by Congress in the First Deficiency Act, the Bureau of Entomology will conduct special trapping experiments and extend its investigational work against the oriental fruit moth. Of this item, $80,-

000 provides for large-scale experiments with bait traps, to be carried on in two fruit sections, an area including 500 acres of peaches to be baited in each section. It is hoped that these experiments will answer the question which has long existed as to whether the use of bait traps over a wide area would give better results in the control of the oriental fruit moth than when a limited area of only a few acres is baited, in which case the surrounding unbaited area is in comparison very large. W. P. Yetter, Jr., has been placed in charge of the bait work. In addition to the maintenance of bait traps over large areas, important detailed experimental work is also contemplated. The localities selected for the work to be conducted during the season of 1930 are Cornelia, Georgia, and Vincennes, Indiana. The remaining $20,000 of this money is to be used to strengthen the work with parasites and insecticides and for a study of the ecology of the oriental fruit moth. The work with parasites and ecology is to be headquartered at Moorestown, N. J., under general supervision of L. B. Smith, and will constitute an enlargement of work already being conducted by Dr. H. W. Allen. The insecticide studies will be conducted at Vincennes, Ind., under the direction of Dr. F. H. Lathrop.

DISCUSSION

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE AGAIN

THE proposal suggested by the Smithsonian Institution to revive the publication of the International Catalogue of Scientific Literature on a very modest but well-considered budget is a challenge to all scientists and librarians, and to all trust agencies which are spending good money for the promotion of research.

It is suggested that a revolving fund of $75,000 and one thousand library subscriptions of $50 for seventeen volumes will insure the enterprise. Whether or not this is enough is a detail. If this catalogue or something like it is an indispensable tool for research, as many first-class scientists seem to think, then any necessary amount should and probably can be had. If the catalogue is not needed, too much money is now being spent on it. Why waste more?

The Smithsonian raises this question plainly. Why ask the American government to continue to appropriate six or seven thousand dollars a year in the procrastinated hope of a resurrection, if the project is better dead? If it is needed, why procrastinate?

By putting the question the institution has deserved the thanks of all concerned. It is to be hoped that it will not let the matter rest until it has a square answer from all responsible parties. The history of the enterprise for ten years has been one of evasion, with preferential attention to other matters. Meantime a valuable asset of 2,500,000 manuscript titles, costing at least a million dollars, has lain unused and unusable, and another quarter of a million dollars more or less has been spent on half a million more titles, while marking time for responsible agencies to make up their minds or debtor nations to balance their budgets.

To a thrifty librarian the fact of these accumulated assets, together with the fact that the catalogue is a going concern with fifty to one hundred thousand dollars possible annual income, is the crux of the matter. The question raised by the Smithsonian is not the question of presenting a new project to be justified, financed and initiated, but whether perfectly good machinery worth at least $3,000,000 is to be scrapped, in an enterprise bound to be revived sometime, as Professor Armstrong, of the Royal Society, prophesies and as many scientific bibliographers in many countries are on record as believing.

It is at this point that the overture of the Smithsonian becomes a matter of practical business concern both to the research trust endowments and to the libraries. The research endowments are bombarded with bibliographical projects of varying method and degrees of merit. They aid or support a good many projects. They are deeply concerned as trust organizations to put their money where it will do the most good. Other things being equal they prefer to put it where one dollar will do the work of four. This seems to be a spot where one million, perhaps a quarter of a million, will do the work of four millions. If its usefulness merely averages with these other projects the endowments are likely to feel that its claims come first. It is here they can give the most bibliographical service with the least money. The proposition touches the libraries in a very similar way. If and when the matter is revived it will depend for financing, if not on the endowments, then on library subscriptions. If this machine is scrapped, when a new one is started either a $3,000,000 endowment must be had from promoters of research or a quadruple price charged to libraries.

This leads straight to the crucial question of whether the international catalogue is in fact a primary, essential or indispensable tool in such sense that it is bound to be revived sometime. It no doubt seems a futile and mortifying matter to those who have been deeply engaged in the problem for thirty years that they should have to rejustify and refight a matter which was fought to the finish thirty years ago. But it is fair enough. It is not the only real bibliographical need of science. There are at least two other equally well-defined needs—abstracts and handbooks. Without disparaging the usefulness of these two other tools, it must be confessed that a good case is made by those who claim that something like the international catalogue is the essential and only indispensable tool among the three types.

A dispassionate general bibliographer must recognize that this is a conclusion towards which the whole history of bibliographical experience tends. The complete survey, *in full title form*, of the whole literature of any subject or group of subjects is the only solution of the main need of the student in research and in the higher learning, *i.e.*, completeness, and the best solution as to his need for a perspective.

The reason for this lies in the cooperative nature of advanced intellectual work. Intellectual progress, in whatever line, is based on gathering together the results of all previous intellectual work on a particular subject, large or small, surveying, integrating and building on this foundation. This collected and integrated material serves as a necessary basis both for those who, by teaching or reading, are at work turning scientific discovery into common knowledge, and for those who use the same integrated material as basis and point of departure for research effort to produce some new and useful variation, or contribution to the subject. If the research worker misses some result of work previously done, it involves at least the waste of having to do it over again, and it may involve loss of efficiency through the missing of some key fact.

The evidence that the full title method, as distinguished from the abbreviated or index method on the one hand and the annotated title or abstract on the other, is best, is that the title is just what bibliographical experience has evolved as the shortest description of the work or article which will serve. It is itself an abstract, made by the author himself to describe in the briefest way that he can devise what he considers the gist of the article. No other system of abstracts can pretend to describe a group of articles as well in the same number of words.

In short, bibliographical experience confirms the judgment that something "very like" this catalogue as to completeness is the essential, and full title method best, without prejudice as to variety in other details.

The obvious question at this point is, if the matter is so plain, in the nature of the case, in bibliographical experience, in the judgment of scientific bibliographers and users, in its financial aspects and in its waste eliminating and efficiency promoting character, why has the catalogue not been revived long ago?

There are in fact reasons which might well have hindered the most worthy of enterprises.

In the first place, there were the war debts. The temper of the congress of regional bureaus in 1922 was so decided in favor of revival that the committee appointed by it might likely have made progress in getting support from the respective governments for the overhead editing and printing also if it had not been for the war debt situation. The committee found on inquiry what has since been confirmed under renewed inquiry, that under the debt repayment condition it has been difficult enough to keep up on the work of the national bureaus and quite impossible to ask to add to the post-war budgets for overhead and printing in view of the sharp watch and criticism by creditor nations on all budget increases.

Another reason thought to be decisive by Professor Armstrong is the growing passion for specialization among scientists which makes them indifferent to the seeing-as-a-whole aspects, promotes a scramble for special privilege and blinds to the economies of wholesale and machine production in bibliography, as against desultory special bibliographies.

Again, the initial demand for a cool $1,000,000 ($75,000 per year for fourteen years) for publishing arrears was in fact a major deterrent. It is a sum big enough to give pause to any project and demand full justification before proceeding. The Smithsonian now proposes to cut this sum out altogether, leaving arrears to the future. At any event this problem of arrears could be fairly provided for by simply filing the cards as they are and organizing a modern library card and photostat information service, at a cost of 10 per cent. of the printing estimate.

Finally, there is the matter of means, or rather of connecting with the means, for it seems obvious that there is no serious lack of money for approved scientific bibliography. Very much more money is now spent for this in a desultory and competitive way than would be needed for a comprehensive wholesale handling.

There seems little doubt, if one can judge by the course of other events, that, if the above statement of the situation is sound, some agency for the promotion of research will be glad to furnish at least the minimum means. If it is true that the catalogue fills an essential need, in the best way, on a wholesale scale, which insures the most economical production and low cost to the user, by eliminating wasteful and ineffective casual effort, there is little chance that it will not find reasonable provision, if it can get an adequate hearing.

The problem is, therefore, to get the facts stated in a convincing way and presented by those who have the confidence of the promoters of science.

Of course the Smithsonian itself has its own prestige. It might use this prestige to induce the two great institutions organized for the promotion of cooperation in intellectual work, the League Committee and the National Research Council, to take up this particular question for definite consideration on its merits and to consider the whole situation of the bibliography of science in a broad way with view to inducing the cooperation or amalgamation of existing enterprises. This would reach one of two results: either the promotion of this project in its suggested form, or a modified form, perhaps a highly modified form, in which latter case it would inevitably lead to some project viewing the whole field of bibliography as one; or on the other hand, it would produce a responsible opinion against the catalogue which would justify the Smithsonian in abandoning the project and refusing to apply for further appropriations.

Scientific bibliography has the very high honor in bibliographical history of having been the first to conceive and to carry out on a large scale in the international catalogue the seeing-as-a-whole aspect of things which the modern school of psychologists is now exploiting. It would be an even greater honor if it should lead the promoters of research generally to apply the comprehensive method to other large fields.

ERNEST CUSHING RICHARDSON
LIBRARY OF CONGRESS

WHAT IS CONTROL?

WE fail to understand by what authority, or process of reasoning, Professor Woodworth[1] would limit the use of the term *control* to "definite conscious action of a rational being, something done by man for his own benefit . . . always something that carries out his will."

The dictionaries define control, *v. t.*, in part as follows: "to exercise a directing, restraining, or governing influence over; direct; counteract; regulate" (Standard); "to exercise control over, in restraining or checking; to subject to authority; direct; regulate; govern; dominate" (Century); "to exercise restraint or direct influence over, to dominate, regulate; hence to hold from action, to curb, subject, overpower" (Webster). One could scarcely formulate a truer picture of the present-day aims of economic entomologists, with reference to our insect enemies. Nowhere do we find a definition that restricts the term as postulated by Professor Woodworth. *Uncontrolled*, to our way of thinking, means a condition where control by man or by any other factor is not sufficient to restrain or dominate.

Professor Woodworth apparently objects to including under control the action of parasites and predators. Certainly a parasite or predator which destroys a noxious insect is "counteracting," "curbing" and "exercising a restraining influence on" the development of that species. Whether or not it is conscious of what it is doing, or is carrying out its own will, makes no difference in the end result.

Is it not time that biologists, at least, should recognize that man is an animal and a part of nature, by discarding the term artificial for all his relations to the rest of the organic world? In a very real sense, man's fight against his insect enemies is as natural as that of a parasite or predator. Until we are positive that "definite conscious action" is found only in the behavior of the human species it may be unwise to emphasize unduly our separation from the rest of the animal kingdom.

We also fail to follow the connotation that remedies are necessarily eradicative. The term remedy seems to be used at present chiefly to designate pharmaceutical preparations or medicines used for the cure or relief of diseases or ailments. These, we are too sadly aware, are generally far from being eradicative. Remedies, like treatments, imply that the trouble which they are aimed to correct has already begun. Preventive measures, on the other hand, are anticipatory, and are aimed to ward off, or stop the trouble from happening, by the application of previous measures. Remedies, treatments, preventive measures, parasites and predators—all "counteract" or "restrain" the pests against which they are used, and therefore control seems to us to be the best general term.

We would include under the general comprehensive term insect control all adverse operations and ecological conditions that make life hard for insects, that tend to kill them or to prevent their increase in numbers or their spread over the earth. As so defined, insect control may then be classified as follows:

A. Applied control: measures that depend upon man for their application or success, and can be influenced by him to a considerable degree.
   1. Chemical control: the use of insecticides and repellents, substances that kill insects by their chemical action or ward them off by their offensiveness.
   2. Physical or mechanical control: special operations that kill insects by their physical or mechanical action.
   3. Cultural control: regular farm operations performed in such a way as to destroy insects or prevent their injuries.
   4. Biological control: the introduction, encouragement, spread and increase by human aid of

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[1] SCIENCE, 71: 388, April 11, 1930.

predacious and parasitic insects and other animals and insect diseases.

   5. Legal control: the control of insects by controlling human activities.

- B. Natural control: measures that do not depend upon man for their continuance or success, and can not be greatly influenced by him.
  1. Climatic control: the restraining influence of cold, heat, winds, storms and other adverse weather factors.
  2. Topographic control: the restraining influence of natural barriers, such as oceans, rivers, mountains, unfavorable vegetation or soil.
  3. Biological control: the operation, without human aid, of the parasites, predators and insect diseases naturally present in any region.

We believe that there is a perfectly good reason why "the *term control . . . has finally practically displaced* the older term" and why less than 5 per cent. of recent writers on insects and fungi are using other terms in place of it.

C. L. Metcalf

University of Illinois

The appearance of an article entitled "What is Control?" by Professor C. W. Woodworth in a recent issue[1] raises an interesting point. If natural control, as a term, be discarded, as suggested, what substitute may best be employed in less technical bulletins of experiment stations and the like to designate those factors of nature which exert a restraining influence upon organisms, such as injurious insects and fungi, which are the subjects of such publications?

Chapman, Graham and others have developed the term environmental resistance, which has been defined[2] as "the sum of all the factors in an environment that tend to reduce the rate of insect multiplication." These factors are physical, biological, etc. This term, environmental resistance, which is, perhaps, more inclusive in scope than the connotations associated with natural control by some, might well be used exclusively in place of the latter; "natural control," however, is often useful. The impression has been gained that natural control, as a term, need not be abandoned on the basis of the argument of the article mentioned.

After a lucid and rather satisfying explanation of how "control" has supplanted such medical expressions as "remedy" and "preventive," Professor Woodworth concludes that "natural control . . . should disappear from the literature of entomology" because, as a term, it is considered self-contradictory and the equivalent, etymologically, to non-control. This objection is based upon the concept that, since the influence of those factors which, properly, may fall into this category is exerted quite independently of man, no control has operated, *i.e.*, control is not control unless initiated, directly or indirectly, by man (or by some other intelligence in the universe acting for the benefit [?] of man), and control "is always something that carries out his will."

This limited and anthropomorphic construction of control is not supported by the opinions of certain lexicologists. Two dictionaries, taken at random, define control as "a check," "a restraint," "the power of keeping checked," "a regulation." No express statement that only man (or a superhuman entity) can exert such an influence is usually to be found; indeed, "one who or *that which* controls"[3] has been noted.

In the article cited, it is further stated that "*uncontrolled . . . is almost universally* expressive of the action of nature where a control by man is not exercised." If it be granted that this usage may hold generally—though, strictly, it does not hold exclusively, and one may conceive of non-human limiting factors that may not, or have ceased to, operate—it still need not invalidate the term natural control. Philological studies have shown the essential plasticity of a living language, as witness *sanguine*, originally *bloody*, then *abounding with blood*, finally *cheerful, hopeful, confident*. As the remark of a colleague implies, the points made against the use of the term natural control might hold with at least equal force (or lack of force) with "natural selection." The article cited does not challenge the fitness of this particular term, which has achieved virtual universal acceptance and which may be said, conservatively, to be good usage.

If "control" may be used as it has been defined: a check[4] or a restriction, it then would seem not excessively arbitrary to add "natural" (belonging to nature, not artificial) to obtain an expression descriptive of such natural factors as parasites, predators, lethal temperatures, fluctuations in the food supply, *et al.*, which—from the view-point of man—do much to limit the injuriousness of certain insects, fungi, etc. In view of the usages of indirect and direct control, chemical and biological control, etc., it should not be amiss to retain, as an antithetical expression for artificial control, the simple and reasonably self-defining term, natural control. It is in just this sense that such eminent entomologists as W. R. Thompson and F. Silvestri have used natural control.

Raymond L. Taylor

Bar Harbor, Maine

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[1] Science, 71: 388, April 11, 1930.

[2] S. A. Graham, "Principles of Forest Entomology," p. 32, McGraw-Hill Book Company, New York, 1929.

[3] Funk and Wagnall's Desk Standard Dictionary, p. 188, 1915.

[4] Incidentally, "check" has at least two meanings for which "control" is used synonymously, *viz.* (1) a restraint, (2) the untreated unit or phase in an experiment.

THE SECOND CAPTURE OF THE WHALE SHARK, RHINEODON TYPUS, NEAR HAVANA HARBOR, CUBA

IN 1928 we put on record[1] the capture of a thirty-two foot whale shark on November 20, 1927, at Jaimanitas, a fishing village in the suburbs of Havana, about five miles west of the mouth of the harbor. Now we have the data for the taking of another at Cojimar Bay about as many miles to the east of Havana, and interestingly enough the new specimen is of about the same size—the former thirty-two feet, the present one thirty-four feet.

On March 10, 1930, a Havana paper contained a notice of the capture of a gigantic "Pez-dama" or checkerboard fish on that day off Cojimar. Investigation confirmed the account. The Havana papers during the next few days printed a picture of the fish drawn up on the beach and gave accounts of its capture which on investigation were found to give the facts. All available data from the papers and from talks with the fishermen have been used in writing this notice.

The accounts, which seem reliable, are that this or another fish had been seen in the open sea off Cojimar for at least three years, and efforts had been made to capture it. So well known was it that the fishermen had dubbed it "El Elefante" from its huge size. That the presence of this fish off Cojimar was common knowledge is attested by the fact that a Spanish merchant, Sr. José V. Fernández, of Havana, had subsidized a crew of fishermen under José González to watch out for and to capture the fish. They had been provided with steel cables, empty metal casks or "drums" and specially made harpoon lines and harpoons. The necessity for the latter will be understood when it is recalled that the skin of *Rhineodon* is from three to four inches thick, and not penetrable by the ordinary harpoon.

The method of capture seems to have been somewhat as follows. Two gasoline launches managed to get a slip noose of small steel rope over the shark's head and around his middle—over the pectoral fins and just in front of the dorsal as is shown in a photograph. The wire cable was then drawn tight, confining the pectorals and hampering the fish's activity. Since this attack took place out on the open sea, in water of some depth, it was necessary to hinder the shark from diving or at least to locate it when submerged. This was effected by affixing (how we have not been able to ascertain) empty metal barrels or drums to the cable. This done and the whale shark being more or less held at the surface, two or three harpoons were thrown into it just back of the head and above the gill region. With *Rhineodon* thus doubly held to the boats, about fifty shots were fired into its body in the endeavor to kill it. We have a photograph in which the wire rope and the harpoons are plainly visible.

The fish does not seem to have offered much resistance to this treatment, and was finally towed and driven from the open sea into Cojimar Bay and stranded in shallow water. A crowd quickly collected and an effort was made to pull the gigantic fish up on the beach. But since the monster was thirty-four feet long and had an estimated weight of nine tons, the utmost efforts of forty men were not sufficient to effect this, and it was finally achieved by putting the fish on a wooden framework (allied to the "stone boat" of New England) and by dragging this up by means of a winch or crane. The fish was still alive when brought to the beach and died some twenty-four hours later—presumably from loss of blood resulting from lance thrusts in the gill region. There seems to be no other method to compass its death, unless by the use of a bomb-harpoon.

The huge fish was finally drawn on the shore where it was covered with an awning to protect it from the sun. Here it was visited by great numbers of people not merely from the countryside but from Havana. The picture published by the Havana *El Diario* was made of the fish under the awning. Later the skin was removed and taken to Havana where it is being mounted for exhibition.

As in the case of the other Havana specimen this fish seems to have come near shore in pursuit of schools of sardines, on which the fishermen allege that it feeds. This, as noted in our former paper, coincides with the other definite information which we have about its feeding habits in the western Indian Ocean.

This fish, a male as was the other Havana specimen, offered no effectual resistance to capture, but seemed very sluggish—even stupid. This indeed seems characteristic of the whale shark. All other specimens taken in the Florida Straits have put up no fights at all, in fact have done nothing save drag the attacking boats around. However, the three captured on the Florida coast (the fourth came ashore dead) have been taken in shallow water where they could not effectively exert their strength. But the two taken near Havana have made no more resistance than did the Florida fish, notwithstanding the fact that they were taken in the open sea, in water of at least moderate depth—water by no means so shallow as to hamper the fish. These two did no more than drag the boats around with them, as the others have done.

In conclusion we may add that the capture of this new specimen of *Rhineodon* is by no means surprising. This conclusion is arrived at because the capture of one other Havana and of four Florida specimens have been recorded from this general region. And secondly, because the head fisherman of the crew that caught the first Havana specimen reports that after the capture of this fish he had two months later seen in the same locality and had tried to harpoon another huge spotted shark. The same reports come to us now for a second specimen in the waters of Cojimar. Then again we have seen recent newspaper accounts (unconfirmed) of a specimen seen off Bimini, Bahamas.

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[1] E. W. Gudger and W. H. Hoffmann, "The Whale Shark, *Rhineodon typus*, near Havana Harbor, Cuba; the Fifth Record from the Straits of Florida," American Museum Novitates, 1928, no. 318, 7 pp., 4 figs.

It is a matter of regret that the demise of Sr. Fernández took place some months before the realization of his dream for the taking of this great shark, the search for which he had maintained for many months. However, the mounting of the fish seems to be going forward under the direction of his widow and of the head fisherman and it is to be hoped that the exhibition of the mounted fish may bring in sufficient returns to recoup at least some of the expenses of its capture and preparation.

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QUOTATIONS

REMARKS ON THE HISTORY OF COSMIC RADIATION[1]

IN previous articles I have never sought to assign the origin or history of the speculative ideas about atom building in cosmic processes—a very ticklish thing to do, since during the past twenty years this question has aroused general interest. But if the historian of this domain can find anything useful in it, I will be glad to contribute my own knowledge of the history of the subject.

In the year 1904, when I was engaged in the study of certain rare ores for their uranium content by the action of radioactivity, Professor F. R. Moulton, of the University of Chicago, came to me with the statement that even if the sun were originally of pure uranium it could not have given up as much energy as he would regard as necessary for a minimum of the life of the sun, and that, therefore, it was necessary to postulate a store of cosmic energy from a previously unknown source for the stellar energies.

Now this source had already been found, although I did not, at that time, fully appreciate it; the interchangeability of mass and energy was demonstrated in 1901 for special cases by the experiments of Kaufmann, and the discovery of radiation pressure some years before was also of great importance. A few years later (1905) Einstein discovered this interchangeability as a consequence of the special theory of relativity, and from this time on this theory was available to any one who, like Professor Moulton, was seeking a new source of energy for the continued existence of the life of the celestial bodies. Certainly, for something less than ten years it was a theme of general table conversation at the University of Chicago. As soon as the Mosleyian relations (1913–14) and the existence of the isotopes were discovered, atom building within the stars, accompanied by a change of the superfluous mass into radiation, was considered as a source of stellar energy. Harkins[2] explained in detail this loss of mass, or packing effect, in the atom building process. I mentioned this fact in the first edition of my book "The Electron."[3]

That this phenomenon is not sufficient to explain the energy of the universe was shown later on. In *Nature* (1917) Eddington mentioned the idea of the annihilation of matter by collision and the complete superposition of the positive and negative electrical fields, and ascribed the idea to Jeans.[4]

Certainly by the year 1915 the idea of the building of the elements from hydrogen as a source of universal energy was prevalent, and in 1917 the total destruction of mass as a more active source found its way definitely into the literature, and was familiar at other universities than Chicago, since these ideas are obvious consequences of the Einstein equations (1905) and the known existence of isotopes (hydrogen with the atomic weight 1.008 instead of 1).

In our conversations at Chicago W. D. MacMillan constantly held out for the view that a still further step forward should be taken and that the idea of the "running down of the universe" should be given up by the assumption that atom building went on in space by the condensation of radiation into atoms. He discussed this idea with me in detail in the year 1915, and in July, 1918, he published it in full.[5] Any one who is interested in the history of this subject should read MacMillan's other articles,[6] since this investigator, on the theoretic side, is the foremost representative of the idea of the development of cosmic energy by the process of atom building.

These three ideas, first, atom building from hydrogen; second, the radiating away of mass, and third, the condensation of radiant energy into atoms, are the three hypotheses for which we have obtained partial experimental proof.

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[1] Translated from the *Physikalische Zeitschrift*, Nr. 6, March, 1930.

[2] *Phil. Mag.*, 30: 723, 1915.

[3] P. 203, 1917.

[4] *Nature*, 70: 101, 1904.

[5] *Astrophysical Journal*, 48: 35, 1918.

[6] SCIENCE, 62, July 24 and August 7, 1918.

Heretofore I have not tried to assign priority to any one with respect to speculative ideas, since we have considered it our problem to show how far our experimental results were of significance to these now familiar ideas. We made a small step forward in giving a quantitative proof for the cosmic origin of the radiation in 1925, in that the longest wave-length observed, according to our method of calculation, agreed with the Einstein equation corresponding to the building of helium out of hydrogen; and last winter (February, 1927) we found clear and authentic proof that this and other atom building processes are actually the source of the cosmic radiation. We proved further, contrary to all previous assumptions, aside, perhaps, from the assumption of MacMillan, that the atom building process does not occur in the stars, but in the depths of interstellar space.

If there is any one besides Einstein who was a pioneer in the development of the theoretical ideas for which we have found experimental proof it is W. D. MacMillan. Any one who since 1918 may have sought to write the history of the atom building processes should have given him a deserved recognition.

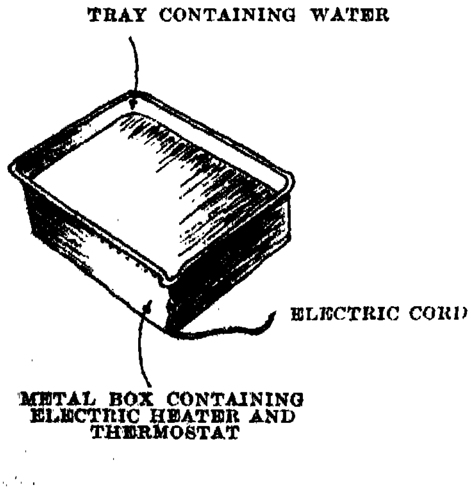
Robert A. Millikan

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN APPARATUS FOR HANDLING PARAFFIN RIBBONS

The need for a convenient means of handling several paraffin ribbons at one time was the incentive for contriving the following piece of apparatus.

A good-sized photographic tray was fitted into the top of a metal box containing an electric heater and a thermostat. The tray was filled about half full of water. Water at a temperature of approximately 30° C. spreads the ribbon out smoothly yet is not so hot as to make the paraffin soft enough to be inconvenient to cut with small scissors.



The paraffin ribbons are cut to about the length of the tray and transferred to the water with a pair of tweezers. The bath is large enough so that several long ribbons can be spread out side by side. With the aid of a strong light and a hand lens the unwanted parts of the ribbon can be detected and removed from the bath. Then the ribbon is cut to proper lengths, the fixative-covered slide is slipped under the section and the piece of paraffin ribbon floated to the exact position.

The tray may be removed and a plate placed on top or the whole box turned over, resulting in an ordinary constant temperature embedding table, which can be used for drying slides and for softening the paraffin before dissolving the ribbon in xylol.

Briefly summed up, this piece of apparatus does the following: (1) Spreads the paraffin ribbon out flat and smooth. (2) Holds several long ribbons. (3) Undesirable parts of the ribbon can be detected and removed. (4) The paraffin ribbon can be easily cut to desired lengths. (5) Provides a convenient method for placing the piece of ribbon on the slide. (6) Turned over it functions as a large embedding table.

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SPECIAL ARTICLES

THE METABOLISM OF THE LOCAL EXCITATORY PROCESS AND OF THE PROPAGATED DISTURBANCE IN NERVOUS TISSUES[1]

In an earlier paper I tried to show that the chemical changes produced in a tissue by means of an electrical stimulation differ from those caused by the physiological conduction of excitation waves. I was at first brought to this opinion by the following facts. Nearly all investigations of the metabolism of the excitatory process in the nervous system were carried out in such a manner that the part to be investigated was stimulated directly. Parker alone for methodical reasons stimulated the nerve outside of the chamber in which the CO_2 output was measured. And whereas nearly all other authors had found the gas exchange increased from 50 to 300 per cent., Parker obtained only an increase of about 14 per cent. This made me suspect that the differences between these results were caused by a difference between the metabolism of the local excitatory process and that of the propagated excitation waves, and induced me to pursue the question further.

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[1] Some of these results have been communicated in an evening lecture at Woods Hole and published in the *Collecting Net*, Vol. IV, No. 8.

One of my collaborators, v. Ledebur, made comparative investigations of the oxygen intake and the CO_2 production of the isolated spinal cord of the frog, stimulating with induction shocks either directly or by way of reflex through the sciatic nerve. In the first case he observed a strong increase of the gas exchange, while the reflexive, that is, the physiological, stimulation produced no increase, or only an insignificant one, in the normal spinal cord. In the organ *poisoned with strychnine, evidently in consequence* of the greater spreading of the excitation, the increase was larger, but still much less than with direct stimulation. It seems to me impossible to explain this in another way than by fundamental differences between the effects of local stimulation and of physiological conduction.

If this is the case with the central nervous system, it must be expected that the peripheral nerve behaves in the same manner. Therefore I performed in the Marine Biological Laboratory of Woods Hole and in the Physiological Laboratory of Breslau a number of experiments concerning the influence which is exerted on the oxygen intake of different nerves on the one hand by the local excitatory process and on the other hand by the propagated disturbance. I used for this purpose a microrespirometer, which allows either a part of the organ situated inside of the respiratory chamber or a part left outside of it to be stimulated by electrical shocks. Using the leg nerves of bull-frogs I was surprised to see that the increase of the gas exchange effected by direct electrical stimulation was incomparably less than I had observed in German frogs. Nevertheless, in a few experiments the increase of oxygen intake was distinct by stimulation inside the chamber, while the conducted excitation produced by the stimulation outside of the chamber did not cause any increase at all. This, however, can be shown much more distinctly with European frogs, which, as mentioned above, have a much larger increase of gas exchange when stimulated. While this increase with direct stimulation amounted to between 50 and 80 per cent., the propagated disturbance again did not cause any measurable increase. The derivation of action currents at the end of the experiments proved that the conductibility had been preserved. From these experiments certainly it must be concluded that the chemical changes produced locally by electrical stimulation differ distinctly from those caused by physiological excitation.

This is also made evident by experiments performed in a similar manner on the isolated spinal cord of the dogfish. Here too the stimulation outside of the respiration chamber did not increase the oxygen intake, while the stimulation inside of it produced an increase of from 40 to 75 per cent. If the movements of the tail on stimulating the spinal cord are taken as a test of excitability, the latter seems to have disappeared after one hour. Therefore in this experiment the physiological conduction was perfectly suspended, while the local excitatory process produced by artificial stimulation was preserved. This shows that the usual method of judging the local excitability by the reactions of a remote end-organ is quite subject to error.

There are a number of observations which agree very well with these ideas. Parker carried out an ingenious experiment about the gas exchange of unsevered nerves. He isolated a large part of the vagus nerve of snakes without cutting it. Then the neck of the animal was bent towards the heart and the vagus looped in the opposite direction. This loop was inserted into the respiratory chamber, where the CO_2 output was measured. No change of this CO_2 output was noted when the nerve was separated from its central and its peripheral connections and thus the passage of all impulses was interrupted. This observation also led Parker to the conclusion that the passage of normal impulses over a nerve does not call for an observable increase of gas exchange. Perhaps also the peculiar difference in the effect of the electrical stimulation upon the oxygen consumption of the nerve in bull-frogs and European frogs may be explained in such a way. It seems very improbable that the physiological conduction should be fundamentally different in animals so closely related; it is much easier to assume that the effect of artificial stimulation differs because of some unimportant structural peculiarities.

The artificial electrical stimulation of an organ has generally two different effects: changes starting the excitation waves and containing the processes of metabolism observable under physiological conditions; besides these changes the stimulation effects further local chemical processes which depend on the intensity of the current and have nothing to do with the processes taking place under normal conditions.[2]

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[2] I think these views agree with the ideas expressed by Dr. Lillie in his review of my lecture (*cf.* the *Collecting Net, loc. cit.*).

For the gas exchange both kinds of changes differ vastly; the large increase of the oxidation, up till now regarded as the expression of the physiological excitation of the nervous system, is only an artificial product of the electrical stimulation. This must not refer to all chemical processes. Some years ago I found with my collaborators that the isolated central nervous system of the frog consumes sugar from the surrounding solution and that this consumption of sugar, especially of glucose, is very much increased by electrical stimulation. Now I performed a new series of experiments, where the sugar consumption was compared when the spinal cord was directly stimulated and when it was stimulated by way of reflex through the sciatic nerves. In contrast to the observations on the gas exchange the result was quite the same in both cases, as well in the normal, as in the strychninized organ. Therefore the increase of sugar consumption is no artificial product of stimulation, but a process really conditioned by the physiological excitation. As the sugar consumption produced by way of reflex is accompanied by only a small increase of oxygen intake, we must conclude that the main part of the sugar does not disappear through oxidation.

I can not close without thanking once again Dr. Jacobs for the extraordinary hospitality shown to me at the Marine Biological Laboratory in Woods Hole.

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THE OCCURRENCE OF A PELLAGROUS-LIKE SYNDROME IN CHICKS

A PELLAGROUS-LIKE syndrome in chicks has recently been obtained at this laboratory in an experiment which was originally designed to throw added light upon an unusual type of leg paralysis occasionally encountered in chicks fed semi-synthetic rations.

The external manifestations of this nutritional disease appear chiefly at the eyes, at the mouth corners and upon the feet. The edges of the eyelids become granular and contract so that vision is restricted. Later, a viscous exudate is produced which causes the eyelids to stick firmly together.

Crusty scabs appear at the corners of the mouth. These gradually enlarge and may even spread so as to involve the margins of the skin around the nostrils and underneath the lower mandible. The skin upon the bottoms of the feet and between the toes peels off. Afterwards, small cracks and fissures appear at these points. These enlarge and deepen so that chicks affected are sensitive to walking.

Feathering is retarded, and the few feathers produced are rough and staring. There is, however, no loss of down or feathers comparable to the loss of hair obtained in pellagra in rats.

Post-mortem examination of chicks that die almost invariably shows the presence of a pus-like substance in the mouth and of a grayish-white exudate in the stomach. The entire intestinal tract is almost entirely devoid of undigested food residues. The small intestines lack tonicity and appear atropic.

The liver is found frequently to vary in color from a faint yellow to a deep dirty yellow, and occasionally it may show hypertrophy. The kidneys reveal a tendency to enlargement and appear grayish-white or inflamed and hemorrhagic.

This syndrome first appeared in a group of White Leghorn chicks when about three weeks of age which were fed a normal diet except for the use of Merck's powdered egg albumin in place of the more common protein of animal origin. At six weeks of age the few chicks remaining averaged 128.4 grams in weight and the mortality was 72 per cent.

The substitution of purified casein for the egg albumin in the basal ration delayed the onset of the pellagrous-like symptoms but gave no improvement in growth. Granulation of the eyelids and encrustation of the mouth corners were less severe in this group, but most of the chicks developed feet conditions just as bad as those in the egg-albumin group. The average weight of these chicks at six weeks was 119.0 grams and the mortality was 36 per cent.

The addition of 2.5 per cent. of autoclaved yeast to the purified-casein basal diet improved growth, prevented granulation of the eyelids and encrustation of the mouth corners but did not prevent entirely the occurrence of scaly, cracked feet. Five per cent. of autoclaved yeast completely prevented all these conditions and produced still better growth. The best growth, however, was obtained by the addition of 10 per cent. of autoclaved yeast to the purified-casein basal diet. At six weeks, the average weight of the chicks in this group was 420.6 grams, a weight 33.4 per cent. greater than the normal average weight for White Leghorn chicks six weeks old used at this laboratory. No mortality was obtained in this group or any of the other groups which had received autoclaved yeast.

The data obtained in this experiment demonstrate the intense requirement of another species for the vitamin or vitamins present in autoclaved yeast, commonly called vitamin B_2, vitamin G or the P-P factor, and indicate that the chick may be a more suitable animal than the white rat for determining the quantity of this vitamin present in food-stuffs.

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THE EFFECTS OF X-RADIATION ON COTTON

In the summer of 1927, during the period when Dr. H. J. Muller was obtaining the first of his notable results on the extent of transgenation induced by X-rays in *Drosophila* and at his suggestion, a population of cotton plants was grown in the greenhouses at the University of Texas to provide material for parallel experiments in the case of a plant species of commercial importance. This original population was produced from seed of a single plant in a highly selected strain of "half and half" cotton supplied by the seed firm of Sumner and Company at Vernon, Texas. The experimental material was, thus, in as relatively homozygous condition as can be obtained in varieties of cotton grown under controlled breeding conditions.

Flowers of these greenhouse plants were emasculated the evening preceding anthesis, and the unopened anthers placed in gelatin capsules. The X-ray treatment was applied the next morning, and the pollen, which by this time had escaped from the anthers, was immediately placed on the stigmas of emasculated flowers. The control flowers were manipulated in the same manner in order to compare the setting of fruit in the two series. It was not considered necessary to keep the anthers of each flower separate for treatment since the individuals in the population were sister plants all having as their parent a single plant of highly inbred origin. The X-ray exposures used were 4, 8, 12, 16 and 25 minutes with a set-up of 50 kv., 5 ma., target distance of 10 cm and an aluminum filter. Seventeen mature fruits, yielding 311 seeds, were obtained from X-rayed pollen × untreated eggs and a larger number of fruits and seeds from the pollinations involving untreated pollen. In the spring of 1929 one half of the seeds from X-rayed pollen were planted in pots in the greenhouse at Berkeley, and from this number twenty-one plants were grown to maturity. The other half were planted in the open, but failed to reach the fruiting stage on account of unfavorable weather conditions. Plants from untreated pollen were grown as a control. It was originally noted that in the seventeen fruits obtained from treated pollen there was a decrease in number of seeds per fruit as the dosage became heavier. A further evidence that sterility was a by-product of the treatment is seen in the production of only twenty-one plants from over 150 seeds.

In external morphology many of these twenty-one plants were altered as compared with sister plants from untreated pollen. Among the more striking of these alterations in character expression was the presence of twisted and deformed stigmas, anastomosing leaf veins, peculiarities in leaf shape, fasciated and enlarged stems, incomplete flowers and dwarfness in habit. Only twelve of the twenty-one plants produced fertile fruits during the 1929 growing season, and seeds from two of these were empty. Three plants were obtained from seeds of the 25-minute dosage. One of these died before reaching maturity, and the other two failed to produce mature fruits.

An examination of the seeds of the ten fertile plants with perfect seeds shows a marked degree of variation as compared with seeds from the control plants. The uniform size of "half and half" seeds is one of the striking features of this variety of cotton, and in a quantity of seed it is hardly possible to select noticeably large or small seeds, so uniform is this character. Of the ten fertile plants mentioned above three produced seeds very much larger than the average size in the control. More striking, however, was the variation in the character which concerns the attachment of the lint in the mature seed. In "half and half" every fiber is attached to the seed at maturity, and must be pulled away in ginning. Two plants of the ten produced seeds from which the lint was entirely free at maturity, resulting in what might be termed "naked seeds." Three plants produced seeds which showed this character to a noticeable extent. In none of the control plants did this character appear.

Cytogenetic analysis of this X_1 generation is in progress and X_2 progenies are being grown. The information in hand suggests that quantitative and qualitative alterations in the hereditary material may readily be induced in cotton by treatment with X-rays. On the basis of these initial experiments it is anticipated that evidence may ultimately be forthcoming which will parallel the results obtained in this laboratory as to the deep-seated effects induced by high frequency radiation in tobacco, another species of economic importance.

J. W. McKay
T. H. Goodspeed
University of California

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THE ORIGIN OF MAN FROM A BRACHIATING ANTHROPOID STOCK

By Professor WILLIAM K. GREGORY

AMERICAN MUSEUM OF NATURAL HISTORY

I. A COMPARISON OF THE LIMBS, HANDS AND FEET OF MAN, ANTHROPOID APES AND PRIMITIVE EOCENE MAMMALS[1]

Recent attacks on the "ape-man theory" by Professor Henry Fairfield Osborn have been misinterpreted by many newspaper writers and preachers to mean that what they choose to call the Darwinian hypothesis of man's origin has been demolished by America's foremost paleontologist, so that many now feel that man's anatomical bonds with the apes may safely be ignored or explained away. It is true that in stressing the wide psychical gulf between man and the apes Professor Osborn did not at first explicitly provide his "Pro-Dawn Man" with any assignable ancestors among the lower animals. But those who prematurely welcomed Professor Osborn to the ranks of the anti-evolutionists seem to have overlooked several striking passages in [illegible] Des Moines address.[2] Here he [illegible] states that he is "not ignoring the overwhelming evidence [illegible] remote community [of] origin [illegible] man and the anthropoid apes"; and that [illegible] combating the special feature of the La[illegible] hypothesis that man once passed into [illegible] arboreal adaptations attained by [illegible]; finally, he is "inclined to separate the human stock at a geologically earlier pre-[illegible] of anthropoid evolution." Moreover, [illegible] diagram illustrating his "present [illegible] and phylogeny of man" agrees in [illegible] "family tree of man" (1921, 1924), the chief difference being that the point of initial differentiation of man and the anthropoid apes is placed one geologic epoch earlier in his diagram than in mine. Hence that which was often represented in the public press as a revolutionary overturning of the Darwinian hypothesis of man's origin differs only in details from that version of the Lamarck-Darwin theory which has been developed and expounded by Sir Arthur Keith since 1893, by Professor G. Elliot Smith for many years past and by the present speaker since 1916.

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[1] Based on papers read before the Charlottesville, Virginia, meeting of the American Association of Anatomists and the American Association of Physical Anthropologists, April 18 and 19, 1930.

[2] [illegible], 71: 1–7, January 3, 1930.

A careful study of Professor Osborn's recent papers shows that there are not less than fourteen points in which his theory is in entire accord with that which I am defending. These fourteen points will be discussed in the paper of which this is an abstract. On the whole they will probably arouse far less dissension in the world than did the fourteen points of Professor Osborn's *former colleague at Princeton.* Certainly they afford a basis for further progress toward agreement, especially since Professor Osborn concedes: (*a*) "the overwhelming evidence of a remote community [of] origin between man and the anthropoid apes"; (*b*) "the strong evidence for an Eocene arboreal stage in our ancestry," and (*c*) that "in the forest remain all the backward, conservative types, while on the plateaus and uplands are found the alert, progressive, forward-looking types." Thus we have made progress toward the conclusion that although man may have been a plateau-living biped for millions of years, his ancestry eventually merges with that of the conservative forest-living, originally arboreal anthropoids.

There are, however, ten remaining points in which Professor Osborn's theory diverges from mine, all of which are discussed in this paper as it will appear in the *American Journal of Physical Anthropology.* Of these, the most fundamental difference is that while admitting the existence of a common ancestral stock from which man and the anthropoid apes are both derived, Professor Osborn eliminates from the human line the "brachiating stage" through which the early anthropoid undoubtedly passed, while Keith, Gregory, Morton and others regard at least a moderate amount of brachiation as an indispensable prerequisite for the assumption of erect bipedal posture on the ground. Brachiation, as first used by Keith, means that method of progression in the trees in which the suspension grasp is employed by the arms, which are held above the head, while the backbone is in general vertical to the plane of progression. One need hardly say that the hind limbs of brachiators are of the grasping type. Other modes of progression are of course employed by the chimpanzee and gorilla when on the ground, and they do not invariably brachiate even when in the trees. Nevertheless they are evidently derived from partly brachiating ancestors, as shown by the construction of their skeletons.

In his Des Moines address referred to above, Professor Osborn did not discuss in detail the great mass of osteological and other anatomical evidence for the descent of man from early brachiating ancestors which has been set forth by Keith, Morton, Gregory, Schultz and others. He merely implied that resemblances of this kind might be due to the independent derivation of man and the anthropoid apes from Eocene mammals with divergent first digit. It is this last suggestion of Professor Osborn's that I desire to consider here.

At one time or another I have examined practically all the known types of hands and feet of Eocene insectivores, carnivores, protoungulates, artiodactyls, perissodactyls, rodents, edentates and primates. Many of these will shortly be described in Professor W. D. Matthew's memoir on the fossil mammals of the Lower Eocene. In all the more primitive representatives of the Eocene groups the hand is pentadactylate with a somewhat fan-shaped radiation of the metacarpals and digits. The thumb is well developed and divergent. The carpus is shallow, the bones in general being more or less widened, except the magnum or capitate, which in the front view is quite small. The centrale is distinct. The ungual phalanges are compressed and doubtless have sharp claws. This general type of hand was probably very near to the basic type for all the placental orders, but it has not taken even the initial steps toward the human type. None of the hands of non-primate mammals of Eocene age therefore offer any evidence in favor of Professor Osborn's suggestion that the human hand may be derived independently of the anthropoid ape type from some primitive Eocene mammal with a more or less divergent thumb.

The generalized primate type of hand was already in existence in Eocene times and had advanced far beyond the generalized placental type described above. In the Eocene lemuroid genus *Notharctus,* elsewhere described by me, the fingers are long and slender, the thumb relatively short but mobile, the capitate or magnum is extended vertically and the carpus decidedly narrow as compared with that of the ordinary Eocene mammal. This was the primary arboreal adaptation of the primate hand in Eocene times, and even in man the hand still abounds in unmistakable tokens of derivation from arboreal ancestors.

If we compare, for example, the skeleton of the hands of man, gorilla and chimpanzee, we shall see that while the hand of man is extremely different from that of the prototypal Eocene mammal, it is extraordinarily close to that of the gorilla in its fundamental features, differing chiefly in the length of the thumb and the shortness of the metacarpals.

Many deep-seated resemblances between man and the gorilla are to be seen in the carpal bones. In both forms the navicular (scaphoid) is placed vertically in a peculiar way so that the articular surface extends from the lunate down past the upper end of the capitate (magnum) to the lesser multangular (trapezoid). Almost every process on the carpal elements of gorilla is represented by a more or less reduced process in man. These processes are better seen in the so-called primitive races, such as Australians and Negroids, than in the more or less reduced, degenerate hands of pen-using white men.

Along with these resemblances between man and gorilla are numerous differences in the carpals of these two forms. Here belong especially the reduction of the pisiform in man, the enlargement of the lesser multangular in the rear view, the reduction of the great processes on the palmar side of the hamate, capitate (magnum), etc. These differences are doubtless associated partly with the fact that the gorilla still uses its hands in locomotion, while in man this function has normally long since been given up.

The persistence of so many and great resemblances notwithstanding the marked differences in locomotor habits between gorilla and man assuredly testify to the arboreal heritage of the human hand. Of all the anthropoids the nearest approach to man in the general construction of the bony hand is made by the gorilla. Now the gorilla, as may be testified from field experience, has not yet given up wholly the brachiating habits of his ancestors. Hence I infer that the strong resemblance in the hand skeleton of gorilla and man supports my contention made on other grounds that the skeleton of man retains many unmistakable souvenirs of a former brachiating stage.

If all these striking resemblances both in the skeleton and the general anatomy between the hand of man and that of the chimpanzee and gorilla are to be ascribed solely to parallelism, then what sort of morphological evidence would ever be accepted as evidence of genetic affinity?

If such degrees of resemblance between man and gorilla held only in the comparison of the hands alone, those who ascribe these resemblances to convergence or parallelism might have a stronger case, but the fact is that similar degrees of resemblance, associated also with differences, may be found in many other parts of the skeleton and soft anatomy.

Since space is lacking for the comparison of many parts of the skeleton of man with those of anthropoid apes and Eocene mammals, I shall deal here only with the humerus and the foot.

The facts show that the humerus of man is incomparably nearer to that of the brachiating chimpanzee than it is to the humeri of relatively primitive quadrupedal mammals of the Eocene. Comparative study shows that the humeri of the primitive Eocene mammals, which so far as known were all quadrupedal either on the ground or in the trees, have a relatively short stout shaft, the so-called supinator crest is large and prominent, there is a large entepicondylar foramen, the deltopectoral crest is flaring and ends above in a large greater tuberosity. In chimpanzee, gorilla and man, on the other hand, the shaft is long and narrow, the supinator crest is vertically elongate and narrow, the entepicondylar foramen is normally absent, the distal trochlea is separated from the capitellum by a prominent edge or ridge. Near the upper end the deltopectoral crest is low and vertically elongate, the bicipital groove is pronounced, the greater tuberosity is much reduced and tends to be paired with the lesser tuberosity, the head is globular and directed more upward and less backward than is the case in the humeri of Eocene quadrupedal mammals. Assuredly no unprejudiced authority, in the face of such cumulative evidence, could ascribe all these resemblances between the humerus of man and those of modern apes to pure parallelism, or still less to convergence. And it may be noted that by reason of his still essentially brachiating type of pectoral girdle, humerus, forearm and hand, man has not wholly lost the ability to brachiate effectively, at least in childhood or after practice and training.

As to the suggestion that the human foot might be derived from a generalized Eocene mammalian type with more or less divergent hallux, we may note that in these primitive Eocene mammalian feet the digits all diverge in a fan-like manner and there is as yet no suggestion of the progressive dichotomy or biramous condition which is so strongly impressed on the feet of all known primates, including those of Eocene times. This fundamentally biramous condition, which was characteristic of all the known families of Eocene primates, shows that even at this remote epoch the order of primates was thoroughly arboreal in habit. Even in man the biramous character of the foot is still so pronounced that it affords one of the clearest possible evidences that man shares with all other primates the primary arboreal heritage, while much the nearest to him in point of foot structure are the brachiating anthropoids.

In conclusion, it may be said again that the available evidence of comparative anatomy and paleontology appears to support the statement that in all the bones of his limbs, hands, feet, pectoral and pelvic girdles man is demonstrably nearer to the brachiating gorilla and the chimpanzee than to the primitive Eocene quadrupeds.

II. THE IRREVERSIBILITY OF EVOLUTION AND THE ORIGIN OF THE HUMAN FOOT

In his recent papers on the origin of man Professor Osborn has cited Dollo's "law of the irreversibility of evolution" as debarring the whole anthropoid ape group from human ancestry on account of their loss of certain anatomical characters which have been retained by man. No doubt each modern anthropoid has many of these specializations, which should not be looked for in the ancestral common stock of both apes and man. But as to the particular characters which are to be classified under this heading there is considerable diversity of opinion. The object of the present paper is to examine several well-documented cases of the irreversibility of evolution in order to determine whether my previously published views as to the evolution of the human foot and the human dentition are in accord with this principle.

The skulls of titanotheres (extinct hoofed mammals that ranged from the lower Eocene through ascending geologic horizons to the summit of the Lower Oligocene of western North America and then became suddenly extinct) are fully figured in Professor Osborn's recently published monograph on the "Titanotheres." I had the pleasure of twenty years' close association with Professor Osborn in this work and made the measurements which are the basis of the following statements.

In the Lower Eocene the skull of the very primitive titanotheres then existent was elongate and the preorbital part of the face was about 47 per cent. of the basal length of the skull. In the final stage the preorbital length had shortened to 12 per cent. Here then is an example of differential or disharmonic evolution, one part shortening, while another lengthens. Such changes in proportion have been called by Professor Osborn *allometrons*.

During the same period a pair of bony protuberances, the so-called horns, grew out above the orbits, and finally they attained an elevation above the base of the nasal bone equal to 44 per cent. of the basal skull length. Here was an example of an excessive growth concentrated in certain definite spots. Such outgrowths have been called by Professor Osborn *rectigradations*.

In the top view of these same skulls equally interesting changes take place. The earliest skulls are relatively narrow both across the cheek arches and across the parietal region. Thus in the first stage the zygomatic breadth is but 50 per cent. of the basal skull length. In the succeeding stages the skull increases rapidly in absolute length but it also increases still more rapidly in width across the zygomata, so that in the latest stage the width may rise to 87 per cent. of the basal skull length.

Here then a period of rapid widening has supervened upon an earlier period in which the skull was relatively narrow. In one of Dollo's earliest papers on the irreversibility of evolution is figured the skeleton of the foot of an Australian marsupial *Trichosurus*, which may be taken to represent an ancestral stage, already highly adapted to limb-grasping habits, while compared with this is the foot of the gigantic ground-living form *Diprotodon*, the drawing reduced to approximately the same length. It will be seen that notwithstanding the enormous thickening and enlargement of the tarsals and fifth metatarsal in order to support the gigantic weight, the heritage of a former arboreal life is deeply impressed in the peculiar characters of this foot. One may notice, for instance, the divergent position of the great toe, the subequality of digits II and III and the greater length of digit IV as compared with digit III. Digit V, however, has received a great secondary increase in size.

Here then was a capital example of the fact that evolution is irrevocable, that later stages bear in themselves the more or less visible imprint of past adaptations to earlier methods of locomotion. This case likewise clearly instances the disharmonic or differential increase of one part as compared with its neighbor which occurs when an old method of locomotion (namely, tree-climbing) is abandoned and the habit of walking on the ground is assumed.

A fourth instance of the same principle is afforded by the known facts concerning the evolution of the feet of the titanotheres, as set forth in Professor Osborn's monograph. One of his figures[3] shows the forefeet of the earliest and later members of the group drawn to the same scale. It will be seen how massive and broad the gigantic later forms are in comparison with their diminutive narrow-footed ancestors. The upper figure on the same page shows the early, middle and late stages all reduced to the same absolute height. Now in the first stage, compared with other mammals, the foot is already remarkably high and compressed, but then a period of broadening supervenes. The carpal bones become broader and flatter, the metacarpals widen at different rates so that metacarpal IV becomes nearly as wide as metacarpal III, as in the hippopotamus. Meanwhile the phalanges or true digits have suffered a marked shortening, the ungual phalanges being relatively reduced.

Thus we see in these cases that, although evolution is irreversible, or rather irrevocable, the tendency toward length and narrowness, which is very obvious in the earlier forms, becomes masked by a tendency toward broadening, which involves radical alteration in the general pattern of the carpal and metacarpal elements.

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[3] *Op cit.*, p. 801.

During the same period of evolution of the titanotheres there were marked changes in the relative lengths of the various segments of the limbs. As the animals got heavier, they gradually gave up the light springing movements of their gracefully built ancestors and took on elephantine striding movements. This change in method of locomotion was accompanied by a marked alteration in the relative lengths of the different segments of the limbs. The femur became longer, the tibia shorter and the metatarsals much shorter. In brief, there was differential or disharmonic evolution of the relative lengths of the limb segments in adaptation to a new method of locomotion.

Still greater changes in the relative lengths of the various limb segments take place when an animal habituated to one medium begins to invade another. Take, for instance, the evolutionary history of the seals. They are of course an aquatic offshoot of the order Carnivora. Although we do not know, or have not yet recognized, their direct ancestors among the terrestrial mammals of the Eocene epoch, the construction of their brains, skull, dentition, soft anatomy and skeleton indicates that these terrestrial ancestors were placental carnivores with ordinary pentadactyl hands and feet. In the group of sea-lions (Otariidae) as well as in the true seals (Phocidae) the feet have undergone profound modifications which have enabled the animals to become highly efficient swimmers. The first digit of the hand of the sea-lion has become much enlarged; the hind foot has become fan-shaped with enlarged first and fifth digits. In the true seals the hind limbs are permanently extended backward and no longer capable of being drawn forward to support the body on land.

Here then is an example of the differential enlargement of certain digits and the rotation of the hind feet through an arc of 90°. Evolution is doubtless irrevocable, but when a race migrates into a new medium a real transformation of the limbs may ensue.

The ordinary pentadactylate feet of primitive Eocene terrestrial mammals had an evenly radiating or fan-like arrangement of the digits. But when the earliest ancestors of the primates took to the trees this even, fan-like symmetry of the digits of the hind foot was disturbed by the marked enlargement of the hallux and by its wide separation from the other digits. I have elsewhere reviewed the strong evidence tending to show that this biramous arrangement of the hind foot was a primary adaptation in the entire order and that even in man there are many indubitable traces of this condition. Traces of this biramous condition seem to be especially marked in the feet of Veddahs, figured by Paul and Fritz Sarasin.

In 1916 I summarized some of the changes which would be necessary in order to derive the human foot from a gorilloid type (using that term in a wide sense). Professor Schultz, after reviewing the embryological evidence, finds that many of these changes as inferred by me are actually passed through in the embryonic history of the human foot, in spite of the fact that in many other cases the embryonic history does not repeat the phylogenetic history.

The foregoing review of examples of fairly well-documented cases of evolution shows that the transformation of a gorilloid into a human type of foot would require no unusual or unprecedented changes either in degree or in kind.

In the first place, even in such a highly specialized foot as that of man, the old biramous heritage is inescapable, so that we must infer that the binding of the great toe to the others by means of the deep transverse metatarsal ligament is surely a neomorph. As it is evident how far nature can go in pushing a digit into a new position (as when the index finger in the Koala becomes aligned with the thumb), it was surely not difficult for nature to draw the outer toes and the inner toe together and to bring about the moderate twisting of the heads of all the metatarsals that was necessary for a firm stance on the ground. These changes were effected partly also by the differential growth of all the tarsal elements: the three cuneiforms and the cuboid becoming elongate proximo-distally, the talus being displaced on to the dorsum of the arch and the calcaneum assuming a much greater burden and becoming much widened transversely. The extreme reduction of the phalanges is so obvious from a morphological view-point as to require no special emphasis.

In this case the doctrine of the irrevocability of evolution is beautifully illustrated by the obviously gorilloid heritage underlying all these special adaptations to bipedal locomotion on the ground.

III. IRREVERSIBILITY AND THE HUMAN DENTITION

The human dentition also abounds in evidence both of the irreversibility of evolution and in traces of the derivation of man from a primitive brachiating ape ancestor of the "dryopithecoid" type. The recent intensive studies of Remane on the incisors, canines and premolars of man have left no reasonable doubt that the small canines of man have been derived by reduction from larger and more ape-like canines or that the simple-rooted lower premolars have been derived from more ape-like conditions. Similarly as to the molars, it has been shown by Gregory and Hellman that the molar patterns of primitive man abound in souvenirs of ape ancestry.

The *"Dryopithecus* pattern" of the lower molars of apes is characterized by the possession of three large cusps on the outer side of the molar, two on the inner side, and five principal grooves, a fovea anterior or precuspidal fossa and a fovea posterior or postcuspidal fossa of Hrdlička. In the molars of the oldest known fossil men this same arrangement of five primary cusps and five principal grooves and two foveæ is incontestably present. In many primitive human molars, however, a sixth cusp is often present. In general, human lower molars are relatively wide and short as compared with anthropoid molars, a period of widening having masked an earlier, more elongate form.

In modernized human molars the *Dryopithecus* pattern is almost completely transformed, chiefly by the reduction of cusp 5 and the loss of the fourth primary groove, so that a plus pattern appears, which at first sight has very little resemblance to the primitive *Dryopithecus* pattern. The plus pattern once acquired also masks the derivation from the *Dryopithecus* pattern. But Dr. Hellman and I have traced so many intermediate stages that the reality of this transformation can be doubted only by those to whom morphological evidence makes no appeal.

In the deciduous molars of man the *Dryopithecus* pattern is fully realized in the second but only very imperfectly foreshadowed in the first. The latter, however, in man is normally much more advanced toward the molar pattern than is the corresponding tooth of the modern anthropoid apes.

In conclusion, the question whether the law of the irreversibility of evolution forbids us to attempt to derive man from a brachiating anthropoid stock allied especially with the chimpanzee and the gorilla may be posed in another way, to wit: Is there, in fact, any known fossil form (other than *Pithecanthropus* and the extinct Hominidæ of Europe) which on the one hand is evidently related to the brachiating stock and on the other hand clearly foreshadows man in many weighty characters?

Photographs of the occlusal surface of the upper and lower deciduous teeth and first permanent molars of *Australopithecus* have been received through the kindness of Professor Raymond A. Dart. This interesting fossil anthropoid from Bechuanaland was described in 1925 by Professor Dart, who has recently succeeded in separating the lower from the upper teeth. It is by his express permission that I am enabled to discuss these photographs. The first permanent lower molar has the complete *Dryopithecus* pattern, together with the sixth cusp so often found in man. The tooth is relatively wider and more human than in any fossil or recent anthropoid known to me. The first deciduous premolar is submolariform as in man and not compressed and premolariform as in the chimpanzee and the gorilla.

The upper dental arch of the same form is even more suggestive of primitive human conditions. Space is not available here for a detailed discussion of this highly significant fossil, but it may be sufficient to state that, after a very careful comparative examination, Dr. Milo Hellman and I have compiled a table of resemblances and differences which may be summarized as follows:

DISTRIBUTION OF *Australopithecus* DENTAL CHARACTERS

Nearer to chimpanzee	0
Nearer to gorilla	2
Nearer to chimpanzee and gorilla	1
Common to chimpanzee, gorilla, *Australopithecus* and primitive man	3
Transitional to, or nearer to primitive man	20
Total	26

A few points of resemblance to the orang are associated with important differences, which indicate that, on the anthropoid side, *Australopithecus* is related to the African rather than the Asiatic genera.

Now in the light of all this additional evidence, if *Australopithecus* is not literally a missing link between an older dryopithecoid group and primitive man, what conceivable combination of ape and human characters would ever be admitted as such?

Evolution is truly irreversible, but its direction can and does change. The facts set forth in many papers seem to warrant the inference that in the remote predecessors of man nature for a long period seemed bent on breeding better and better brachiators. The orang and the gibbon are her most finished products in this direction. But before completing the experiment she segregated some of the more conservative brachiators, turned them out of their forest home and started their evolution in a new direction, that of upright walking on hard ground. *Australopithecus*, to judge from its skull and dental characters, was a pioneer in the new line, as held from the first by Dart.

THE WAVE PROPERTIES OF ELECTRONS[1]

By Dr. C. J. DAVISSON

THE BELL TELEPHONE LABORATORIES

IN an essay published in a recent issue of the *Proceedings*[2] our president has explained to us the nature of thought, and has pointed out its limitations. The circumstance which prompted Dr. Dercum to undertake the exposition of these interesting matters is the difficulty experienced in physics at the present time in forming tangible conceptions of certain processes and certain relationships which have been discovered since the beginning of this century—in particular, the difficulty in forming any mental picture of the so-called quantum processes or of visualizing electrons which behave in some circumstances as particles and in others as waves.

If I follow Dr. Dercum, these difficulties in comprehension arise from limitations imposed upon our thinking processes by the nature of our neural protoplasm. If we were equipped with a better kind of protoplasm, one more completely responsive to stimulations by our environment and capable of a more varied reaction to these stimulations, our comprehension of our environment would be, or at any rate could be, more complete. Things which are incomprehensible to us with our present equipment would in these imagined conditions present fewer difficulties. An individual who has been blind and deaf since birth is capable necessarily of a less complete appreciation and comprehension of his environment than one with normal sight and hearing. And yet the individual with normal sight and hearing is, as we know, blind and deaf to great ranges of light and sound frequencies. It is conceivable even that other forms of stimulation exist in his environment for which he has evolved no receptors whatever. His conception of his environment and of the processes going on within it is, therefore, imperfect and incomplete and must forever remain so. This, as I understand it, is Dr. Dercum's thesis, and it is, I think, a comforting one, as it offers us a legitimate excuse for giving our neural protoplasm a much-needed rest. If elements in our environment are, in the nature of the case, incomprehensible to us, it is certainly foolish of us to waste time trying to comprehend them. The difficulty in pursuing this policy is no doubt that we have no test for distinguishing, *a priori*, the comprehensible from the incomprehensible.

It is not my purpose to discuss this fascinating subject, but to explain to you, as well as I can, one of the circumstances to which it owes its present interest: namely, the duality of apparently irreconcilable wave and corpuscular properties which characterizes electrons. This matter has not, I think, been presented previously to the society. Before speaking of the newly discovered wave properties of electrons, I shall remind you briefly of some of the compelling reasons we have for regarding electrons as particles. It is important to do this in order that you may appreciate more fully the difficulty involved in regarding them at the same time as waves.

It was discovered more than thirty years ago that the many varied and often beautiful phenomena which are observed in highly exhausted electrical discharge tubes—Geissler tubes, Crookes tubes, Roentgen ray tubes and the like—are due primarily to a radiation proceeding from the cathodes of these devices. It was revealed in experiments made by J. J. Thomson in England and by Wiechert in Germany in the closing years of the last century that beams of this radiation are deflected in electric and magnetic fields, in just the manner in which we should expect them to be deflected if the radiation were a stream of swiftly moving negatively charged particles. It was found possible in fact to calculate from measurements of these deflections and other data the velocities of these hypothetical particles, and also the ratio of their electrical charge to their mass. The value found for this ratio was much greater than the largest displayed by any kind of electrolytic ion, and from this it was inferred that the particles are much lighter than the lightest atoms. This evidence of the existence of a subatomic particle of definite charge and mass was readily accepted not only because the evidence was in itself convincing, but also because the idea was not a new one. The existence of an ultimate unit of electric charge had already been inferred from Faraday's laws of electrolysis, and the word "electron" had already been coined to designate this atom of electricity. Also, Lorentz, in attempting to explain the then recently discovered Zeeman effect, had formulated a partially successful theory in which it was assumed that particles of definite charge and mass exist within the atom. The value which had to be assigned to the charge-to-mass ratio of these, in order to obtain agreement of his theory with Zeeman's observations, was the same as that found by

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[1] Read at the meeting of the American Philosophical Society, April 12, 1930.

[2] Francis X. Dercum, "On the Nature of Thought and Its Limitations," *Proc. Am. Phil. Soc.*, 68 (4): 275, 1929.

Thomson and Wiechert in their more direct experiments.

During twenty-five years of intensive experimentation which followed upon the work of Thomson and Wiechert, this conception of the electron as a subatomic negatively charged particle was repeatedly justified and confirmed by experiments of the most diversified kinds. Electrons were found to be a universal constituent of matter. They could be abstracted from any kind of matter in a variety of ways. They could be vaporized from matter by heating; they streamed forth under the solicitation of light and X-rays; they were ejected spontaneously by radioactive materials. Measurements were made of their charge, most precisely in the famous oil drop experiments of Millikan. By combining this result with the most reliable determinations of the charge-to-mass ratio, one could write down a value for the mass of the electron correct probably to within a few parts in a thousand. Estimates could be made of its linear dimensions on the assumption that its mass was entirely electromagnetic. If any doubt had existed regarding the corpuscular nature of electrons, it must have been dispelled by the beautiful experiments of C. T. R. Wilson in which the tracks pursued by individual electrons in traversing a gas are rendered visible. The discreteness of electrons is further attested by the fluctuations which are observed in the current flowing from a heated filament; these are of just the character and magnitude to be expected for the random emission of charges of the known magnitude of electrons.

The corpuscular nature of electronic radiations had been verified in what seemed every conceivable way. The conception seemed adequate and sufficient for all demands which might be made upon it. An elaborate theory based upon this conception of the electron had been built up to explain the optical and electrical properties of matter—and this conception was fundamental also to the famous theory of the atom devised by Bohr. It can not be said, however, that this electron theory of matter was uniformly successful in all its ramifications. It was, in fact, the deficiencies of this theory together with certain new conceptions from the field of optics which led Louis de Broglie to suggest about five years ago that the conception of the electron as a particle might in certain circumstances be found inadequate. The circumstances contemplated were those in which the system under consideration is one of atomic dimensions. It was de Broglie's idea that in cases of this kind certain waves which he conceived of as associated with electrons might be expected to manifest themselves. The conception grew out of the reverse situation in optics in which light had come to be recognized as having corpuscular as well as wave properties, out of the mysterious correlation of frequency and energy which we meet with in quantum phenomena and out of the correlation of mass and energy which appears in the theory of relativity. These were the antecedents of de Broglie's idea, and yet in the last analysis the idea was arrived at by a brilliant leap of the imagination.

It has been immensely fruitful. It has led to a new and remarkably successful conception of the atom from which the corpuscular electron as an essential feature has altogether disappeared. The planetary system of electrons conceived by Bohr is replaced by a medium continuous though inhomogeneous, capable of natural vibrations. The fact that these vibrations take place in general in a space of more dimensions than three, and that we have as yet no idea what it is that vibrates, makes visualization of atomic processes a discouraging enterprise, and yet this is less disturbing to the theoretical physicist than might be supposed. He has outgrown the ambition of Lord Kelvin; he no longer tries to devise a mechanical model of every phenomenon. It has been discovered, in fact, that a certain esthetic pleasure is derived from dealing in calculations with symbols which evoke no mental pictures whatever.

De Broglie's idea has been invaluable not only as the basis of a new theory of the atom, but also as the basis of an entirely new theory of mechanics. And in these developments de Broglie has been himself a leader. In its turn the new mechanical theory has suggested experiments by which the wavelike aspects of electrons might be demonstrated. Many of these experiments have now been made; it is of a few of them that I wish particularly to speak. The simplest of all is the experiment by which it is demonstrated that electrons are regularly or "specularly" reflected from the surface of a crystal. We find when a stream of electrons is directed against the face of a crystal that some of the incident particles return from it without loss of energy, and that most of these recede from the crystal face in the direction of regular reflection. The observation is illustrated in Fig. 1. The incident electrons approach the crystal in this particular case along a direction which makes an angle of 38° with the normal to its surface. The curve on the right indicates the way in which the electrons scattered without loss of energy are distributed in direction; most of them depart in a direction lying in the plane of incidence and making with the normal to the crystal face the same angle as the incident beam. There is a strong and well-defined beam of regularly reflected electrons.

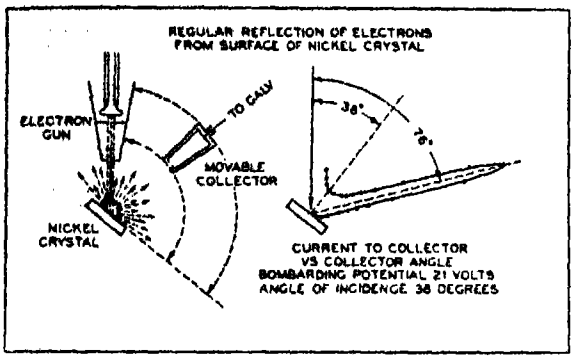
REGULAR REFLECTION OF ELECTRONS
FROM SURFACE OF NICKEL CRYSTAL
ELECTRON GUN
TO GALV
MOVABLE COLLECTOR
NICKEL CRYSTAL
38°
76°
CURRENT TO COLLECTOR
VS COLLECTOR ANGLE
BOMBARDING POTENTIAL 21 VOLTS
ANGLE OF INCIDENCE 38 DEGREES

FIG. 1.

This phenomenon can not be explained in terms of atoms and electrons as previously conceived.

Picture the crystal built up of atoms, each of them enormous in size compared to an electron and each of them comprising a nucleus surrounded by a large number of electrons rotating in closed orbits. Imagine now an electron plunging into this galaxy of planetary systems. It is obviously a comet. The simplest event which may ensue will be a comet-wise deflection of the electron in the field of some atom into which it happens to strike, and then a speeding away of the electron from the crystal without loss of energy. The direction taken by the departing electron will be determined by a number of circumstances, one of which will be the distance from its line of approach to the nucleus of the atom responsible for its deflection. This distance will be different for different electrons—and as a consequence electrons will be scattered more or less uniformly in all directions. This is the picture of electrons scattering in terms of Bohr atoms and purely corpuscular electrons, and it is quite inadequate to explain the strong beam of electrons which is observed leaving the crystal in the direction of regular reflection. This is a direction related to the plane of the crystal surface. Three atoms at least are required to fix this plane, which means that the incident electron has its direction of departure determined not by one atom alone but by three atoms at least. On the older view we should have to suppose that the incident electron in some way takes account of the positions of not fewer than three atoms, and from characteristics of the reflection which I shall mention later we should have to suppose the actual number to be much greater—fifty or a hundred at least.

If, on the other hand, we regard the incident beam as a beam of waves instead of as a stream of particles, the regular reflection is readily explained; each wave-front of the beam comes in contact with all the atoms, and the regular reflection results, as in the case of X-rays, from constructive interference among the coherent secondary wave trains proceeding from the regularly arranged atoms of the crystal. Moreover, this view of the phenomenon enables us to understand the characteristics of the reflection to which I have already alluded—namely, the way in which the intensity of the reflected beam varies with the speed of the electrons and their angle of incidence.

The regular reflection of electrons from crystal surfaces is sufficient to establish the convenience of the conception that electrons are waves. The usefulness of the conception is not, however, limited to this particular phenomenon. There are many ways of demonstrating that X-rays are waves—or perhaps we should say, of demonstrating the convenience of the conception that X-rays are waves. Nearly all these demonstrations have now been made also with electrons. These include the analogues of the Laue diffraction of heterogeneous waves by a single crystal, of the Hull, Debye-Scherrer diffraction of monochromatic waves by crystal aggregates and of the diffraction of monochromatic waves by ruled gratings and narrow slits. The data of these experiments are available for the calculation of electron wave-lengths, and these have the values predicted by de Broglie—a stream of electrons, each of momentum p, behaves in these diffraction experiments as a beam of waves of wave-length inversely proportional to p, the factor of proportionality being the Planckian constant h.

To illustrate further these newly discovered properties of electrons I shall show you lantern slides of two very beautiful diffraction patterns produced recently by Drs. Eisenhut and Kaupp in the laboratory of the I. G. Farbenindustrie at Ludwigshafen in Germany. The first of these was obtained by directing a beam of high-speed electrons through a thin film of silver, and intercepting the transmitted electrons by a photographic plate. The film is an aggregate of tiny crystals of random orientation, and the pattern of rings which appears on the plate is just the pattern which is calculated from the crystal structure of silver and the assumption that the incident beam is a beam of monochromatic waves. The wave-length of the waves may be calculated from the data of the experiment and compared with the theoretical wave-length calculated from the momentum of the electrons by means of de Broglie's formula. The agreement, as has been found in all such cases, is within the limits of accuracy of the measurement. Diffraction patterns of this kind were first produced with electrons by G. P. Thomson, of the University of Aberdeen.

The second pattern I shall show you is by the same investigators, and is for electrons of the same speed. The difference is that the diffracting material is, in this case, a thin lamina of mica. Patterns of this type were produced first by Kikuchi in Japan, and for some time there was no satisfactory explanation of them. The diffracting system is a single crystal; the electrons are homogeneous in speed, the waves are monochromatic. Now it is well known to those familiar with the theory of X-ray diffraction that in general no pattern is produced when a beam of monochromatic waves traverses a single stationary crystal. One or two diffraction beams may possibly appear, but if so the event will be fortuitous; in general no beams will be observed other than the directly transmitted primary beam. Kikuchi should have known better than to make this experiment, but he did make it, and this pattern by Drs. Eisenhut and Kaupp is a beautiful example of the result he obtained. What appears to be the correct explanation of the production of this pattern has been given us recently by W. L. Bragg in England and independently by S. B. Hendricks in Washington. Bragg and Hendricks assume that the mica crystal is to a certain extent a crystal *aggregate*—*not an aggregate* of crystals oriented at random as in the case of the film of silver, but an aggregate of tiny flakes which fail to form a perfect crystal only by being tilted slightly this way and that. This assumption together with the excessively short wave-length of the high-speed electrons employed in these experiments is sufficient to explain the production of this pattern. It turns out to be, to a close approximation, the pattern which would be produced if the diffracting systems were a single layer of molecules instead of some hundreds of layers as it actually is. These patterns also are available for calculating electron wave-lengths, and again the agreement with the de Broglie formula is as nearly perfect as can be expected.

These three phenomena which I have described, the regular reflection of electrons from a crystal surface, the diffraction of electrons by an aggregate of small crystals of silver and the diffraction by mica, illustrate the circumstances in which it is convenient to regard electrons as waves rather than as particles. Whether or not it is possible to achieve a unified conception of electrons in which these newly discovered wave properties appear consistent with their longer known corpuscular properties, or whether such an achievement is beyond the limits of thought, is a question which does not worry the experimental physicist a great deal. It used to be said that a physicist regards light as a wave phenomenon on Mondays, Wednesdays and Fridays, and as a corpuscular phenomenon on the other days of the week. This statement must now be extended to include electrons, and modified, I think, to state that he regards light and electrons as both waves and particles on all days of the week. And it might be added that familiarity with this idea is dulling his sense to its paradoxical nature.

IN HONOR OF DR. WELCH[1]

I INTENDED to throw away my manuscript, but I find that I can hardly trust myself to speak without it. I must speak in my own person and not in that of the idealized figure which has been presented to you.

It is quite beyond my power of words to express the thoughts and the feelings of gratitude which this wonderful occasion has aroused in me. Did I accept merely as a personal tribute these words of praise and this manifestation of appreciation and good-will marked by this large and distinguished gathering and by meetings elsewhere, I should be overpowered with a sense of unreality depriving me of utterance, but I shall assume, as I feel that I am justified in doing, that, by virtue of certain pioneering work and through over a half century of service, I stand here to represent an army of teachers, investigators, pupils, associates and colleagues, whose work and contributions during this period have advanced the science and art of medicine and public health to the eminent position which they now hold in this country.

It is, then, in this representative capacity, as well as personally, that, first of all, I express to you, Mr. President, immeasurable gratitude for the distinction which you lend to this occasion by your presence and active participation. You will permit me to add, Sir, that your presence and generous words of appreciation have a significance not measured solely by the high office which you hold, for you speak with the authority of one who has made memorable and outstanding contributions not only to this nation but to the whole world in the field of public health and social service, especially to the most appealing part of this domain, the health and welfare of infants and children.

And to you, President Farrand, and to you, my old friend and pupil, Dr. Flexner, who have spoken here so eloquently, even if in words all too generous so far as I, personally, am concerned, to Mr. Kingsbury and the other distinguished members of the committees which have arranged this marvelous occasion, to the many citizens, also to the medical officers of the Army, Navy and Public Health Service, members of my profession here gathered, who honor me by their presence, my debt of gratitude is beyond words to express. If my voice carries to an invisible audience, to personal friends and to other gatherings in honor of my eightieth birthday and what it may symbolize, it conveys appreciation and greetings which come straight from my heart.

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[1] Response of Dr. William Henry Welch, delivered in Memorial Continental Hall, Washington, D. C., at the ceremonies celebrating his eightieth birthday, April 8, 1930. The address of President Hoover was printed in the issue of SCIENCE for April 18, p. 411.

While I have been kept in ignorance of the details of these ceremonies, I have been cognizant that the immediate occasion was to be the presentation to me of Mr. Hutty's etching, which, I am sure, in spite of the handicap presented by the subject, he has made a work of art. This I am delighted to accept, and I am still more rejoiced that so many selected institutions and organizations with many of which I have been connected are to receive it.

If it is true, as I have been told, that there are gatherings of friends and colleagues in many places, not only in this country but also in other countries, who are interested in the event here celebrated, I only wish that the time allotted permitted me to tell them—my friends in Germany, whence came my early training and inspiration in pathology and bacteriology, my friends and colleagues in Paris, especially those at the Pasteur Institute, and those in London, Tokyo, Peking and elsewhere—to tell them how much pleasure and satisfaction and inspiration I have derived from their friendship and association. To the favor and support and cooperation of the members of my profession I owe whatever success I have attained.

No one could have been more favored in his professional career by time and opportunity, and by the good work, achievements and cooperation of pupils, assistants and associates, than I have been.

Born only three and a half years after the introduction of surgical anesthesia, I entered upon my professional career in the middle seventies of the last century, before Lister had really triumphed by the general adoption of the principles of antiseptic surgery and just before the demonstration by Pasteur and by Koch of the causation of infectious diseases by microscopic germs. I returned from Germany, thrilled with enthusiasm, at the dawn of the new era, and with some training and capacity to use that master key forged by pathology and bacteriology, which was to unlock secrets of nature destined to transform the face of modern medicine.

Since that time the fundamental achievement which has made possible the remarkable development of scientific medicine in this country during the last four decades has been the great improvement in medical education, with the accompanying creation of laboratories for instruction and research. So brilliant have been the results in discoveries and their application to the treatment and prevention of disease that one is likely to lose sight of the foundation upon which the stately superstructure rests.

Only those can realize the magnitude of this achievement who know something of the condition of medical education in this country fifty years ago, when no one dreamed of endowing medical education and research, in contrast with the condition to-day, when these subjects, together with utilization of opportunities to further and to apply the new knowledge, constitute the most favored and rewarding fields of private and public philanthropy.

I like to think that the primitive little laboratory which I started in 1878 at the Bellevue Hospital Medical College and that of Dr. Prudden, inaugurated almost simultaneously at the College of Physicians and Surgeons of Columbia University, and especially our effort to meet a much larger opportunity, at that time unique in this country, at the Johns Hopkins University and Hospital four decades ago, were not without influence in the improvement of medical education. But the accomplishment would not have acquired the national importance which it has assumed without the participation of other medical schools in the forward movement, the awakening of the medical profession through the American Medical Association and the state licensing boards, and the recognition of the great foundations, first and most important of all, the Rockefeller General Education Board, of the needs and opportunities of the situation.

If I have handed on any intellectual heritage to pupils, assistants and associates, whose work and achievements have been the greatest satisfaction and joy of my life, it is derived from that which I received from my own masters, Cohnheim, Robert Koch, Weigert and others. America is now paying the debt which she has owed so long to the Old World by her own active and fruitful participation in scientific discovery and the advancement of the science and art of medicine and sanitation.

The greatest triumphs of modern medicine have been in the prevention of disease, although the physician's power to alleviate and to heal has also been greatly enhanced. It is perhaps not too much to claim that America has taken a position of leadership in the application of the new knowledge to the prevention of disease and to personal and public hygiene.

But, my friends and hearers, it is my inclination, even at four score years, to look forward, rather than backward, and to avoid a feeling of self-complacency through the rehearsal of past triumphs. All along the line, in the fields of medical education and research, in the study and treatment of disease and injury, in the preservation and improvement of health and the prevention of disease, so much more remains to be done than has been accomplished, the problems awaiting solution are so numerous and pressing, above all, the better utilization of existing knowledge and the need of more knowledge are so obvious and so urgent that our mental attitude should be far removed from satisfaction with existing conditions.

While public health is the foundation of the happiness and prosperity of the people and its promotion is recognized as an important function of government, how wide is the gap between what is achieved and what might be realized, how inadequate is the understanding of the public concerning the means adapted to secure the best results, how small the attractions offered to those entering or who might desire to enter careers in public health through lack of suitable financial recompense, of security of tenure of office, of opportunities for promotion, of standards for eligibility based upon special training and experience and of funds made available for the public promotion of health. Something of the lack of adjustment of the average man to rapidly changing social, economic and political conditions of our complicated modern civilization may be reflected in a certain temporary maladjustment between curative medicine and preventive medicine, which should stand in harmonious relations.

As my immediate and, doubtless, final professorial interest is on the humanistic side of medicine, I may, in closing, be permitted to emphasize the attractions and importance of studies in the history of medicine and of science. We physicians apply the word "humanism" to a period and to a spirit which released the mind from thraldom to authority and contributed mightily not merely to the study of classical antiquity but to the study of nature and of man, leading logically and rapidly to the cultivation of experimental science, between which and humanism, as we understand and use the word, there is no incompatibility whatever.

While nothing can be more hazardous than to attempt to predict the directions of future discovery and progress in the biological and medical sciences, it requires no prophetic gift to be confident that with the widening of the boundaries of knowledge will come increased power to relieve human suffering, to control disease, to improve health and thereby add to the sum of human happiness and well-being. Your presence on this occasion and the wide-spread recognition so conspicuously manifested of the value of services rendered in the field of medical education and medical science are an encouragement to teachers and workers for which I am profoundly grateful and which accentuates the note of hopefulness which I have endeavored to sound.

SCIENTIFIC EVENTS

THE ELECTION OF STATESMEN AS FELLOWS OF THE ROYAL SOCIETY[1]

The president and council of the Royal Society have recommended Mr. Ramsay Macdonald and General J. C. Smuts for election into the society under the special statute which permits the election of "persons who in their opinion either have rendered conspicuous service to the cause of science, or are such that their election would be of signal benefit to the society." It should here be said that the inclusion of certain persons not actually engaged in scientific pursuits is a practice sanctioned by long usage. In the society's original statutes of 1663, it was provided that every one of His Majesty's subjects having the title and place of baron, or any other higher title or place, and every one of His Majesty's Privy Council, might be elected. In process of time, such persons formed a panel or privileged class. However, in 1873, there was much discussion on a motion to require in the privileged class, "evidence of ascertained special power and disposition to forward the aims of the society from exceptionally personal or official advantages of position." Arising therefrom, the privileged class was limited to princes of the blood royal and members of the Privy Council. Statutes enacted in 1902 abolished the clause relating to privy councillors and the basis of qualification remains now as quoted above. Its implications seem clear enough. The opportunities of the chief officer of state in the scientific arena are always at hand; they have nothing to do with political complexities.

In connection with Mr. Macdonald's nomination for election, it is interesting to recall that within the past sixty years four precedents can be recorded for the election of a Prime Minister whilst holding the seals of office. The instances are: Mr. Disraeli, elected on February 10, 1876; Mr. Gladstone, elected on January 13, 1881; Mr. Asquith, elected November 5, 1908; Mr. Baldwin, elected November 3, 1927. The first-named signed the charter book and was formally admitted by Dr. J. D. Hooker, the president, on June 1, 1876—fifty-four years ago—that also being the day fixed for the election of the fifteen ordinary fellows. Amongst these (and happily still with us) was Professor H. E. Armstrong. Mr. Gladstone was admitted on May 19, 1881 (Mr. Spottiswoode was president), on which occasion William Crookes read a paper, "On Discontinuous Phosphorescent Spectra in High Vacua." It fell to Mr. Asquith, in 1912, as Prime Minister, to propose "The Royal Society" at the Guildhall banquet held in connection with the two hundred and fiftieth anniversary of the Royal Society. Mr. Baldwin was formally admitted by Sir Ernest Rutherford, and a similar act when extended to Mr. Macdonald (following election) will provide the circumstance (we think without precedent) of the admission of two Prime Ministers during one presidency. The only Prime Ministers for more than half a century who have not been fellows of the Royal Society by special election or otherwise are Sir Henry Campbell-Bannerman, Mr. Lloyd George and Mr. Bonar Law.

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[1] From *Nature.*

THE ALASKA AGRICULTURAL COLLEGE AND SCHOOL OF MINES

A STATEMENT in regard to the work of the Alaska Agricultural College and School of Mines for the year 1928–1929 has been issued by the Department of the Interior. It is reported that the Bureau of Biological Survey under cooperative arrangement with the college has made very satisfactory progress with its studies in crossbreeding reindeer and caribou. It is also conducting feeding experiments with reindeer to determine the feasibility of "topping off" reindeer before the slaughtering season during later summer. Carrying capacity studies to determine actual acreage requirements of reindeer on various types of forage and plant studies to ascertain the effect of climate on forage growth have been initiated. In order to determine the digestive reaction of the reindeer to different natural forage types, digestive samples and forage samples are being collected for chemical analysis.

In connection with the projects of the Biological Survey, six pasture areas totaling 813 acres have been fenced with net wire and an additional area of 432 acres is now in process of fencing. A herd of 18 caribou and reindeer was pastured and 7 fawns were born last year. In cooperation with the Alaska Game Commission, 3 buffalo were also pastured in these corrals.

The cooperative work with the U. S. Bureau of Mines ever since the Fairbanks Station of the bureau was moved to the college has been highly satisfactory. Mineral determinations are made free of charge and for assays a nominal charge only is made.

The college is said to be strategically situated for carrying on seismological observations in liaison with other observatories throughout the world. The U. S. Coast and Geodetic Survey designed a seismograph for this service.

During the winter of 1928–29 scientific observations of the aurora were inaugurated. The preliminary observations were conducted by V. R. Fuller, professor of physics. The International Geodetic and Geophysical Union at its general assembly in Prague, Czechoslovakia, in 1927 emphasized the need for auroral observation in Alaska, and during April, 1929, the National Research Council indorsed the establishment of such an observatory at the college. The rapid commercial development of radio communication affords an immediate practical aspect to the investigation. A fund of $10,000 was recently donated to the college by the Rockefeller Foundation for this work.

Mr. Otto William Geist embarked on a two years' expedition to St. Lawrence Island collecting anthropological and ethnological specimens for the college. Previous collections made by Mr. Geist in the Bering Sea area have enriched the college museum collection by more than 7,000 items. As a result of his work the college will have an exceptional collection of Arctic specimens and in addition there will be much duplicate material for exchange purposes with other museums. Unfortunately this collection can not be properly exhibited until the college secures a fireproof museum building.

THE UNIVERSITY OF MICHIGAN EXPEDITION TO THE SAN CARLOS MOUNTAINS

AN intensive natural history survey of the San Carlos Mountains of Mexico will be undertaken this summer by a party of investigators from the University of Michigan. The region to be studied is an isolated range of mountains situated about eighty miles south of the Rio Grande, forty miles inland from the Gulf of Mexico and twenty-five miles east of the Sierra Madre front. In this area it is proposed to correlate the distribution of the living flora and fauna with the geologic formations. The San Carlos Range is well adapted for this type of investigation, because of its isolation and relief and because of the diverse types of rock formations exposed. Professor Harley H. Bartlett, head of the department of botany, and Professor Lee R. Dice, curator of mammals in the Museum of Zoology at the university, will study the flora and fauna.

The geology of the San Carlos Mountains is varied and therefore offers in a relatively small area an opportunity for intensive study in several branches of earth science. Professor Edson S. Bastin, head of the department of geology at the University of Chicago, will investigate the ore deposits. He will be assisted by Mr. George W. Rust, a graduate student of the department. Study of the igneous rocks will be carried on by Dr. Edward H. Watson, of the Johns Hopkins University. The stratigraphy and structure of the mountains will be studied by Professor Lewis B. Kellum and Mr. Ralph W. Imlay, of the University of Michigan.

The survey of the San Carlos Mountains with a view to coordinating detailed studies made by specialists in several branches of natural science was planned by Professor Kellum who made a preliminary reconnaissance of the district several years ago.

The party will spend the months of July, August and September in the field. They will make the entire trip from Michigan to Mexico and return by automobile. Each member will work independently and will have with him a mobile camp outfit. The cars can be used in the mountains between points suitable for camps. Side trips into the less accessible portions of the range must be made on horseback and on foot.

The execution of this project has been made possible by grants of $2,500 from the National Research Council and $2,000 from the Faculty Research Fund of the University of Michigan. The scientific results of the expedition will be published as a University of Michigan publication.

PLANS FOR THE NEW BIOLOGICAL LABORATORY AT HARVARD UNIVERSITY

PLANS for the new Harvard biological laboratory have been made public by the architects, Messrs. Coolidge, Shepley, Bulfinch and Abbott, and it was announced at the same time that work on two of the three wings of the building will be started in the early fall. The building of the third wing will wait on the raising of further sums of money. It is believed that this building, when completed, will be the finest and most scientifically equipped laboratory for biological research and study that has as yet been erected in this country.

The new building will be on Divinity Avenue, Cambridge, between the Farlow Herbarium and the Semitic Museum, and adjoining the present University Museum. When completed it will form a quadrangle, balancing that of the University Museum.

Designed as a research laboratory, the building will afford scientifically arranged quarters for the four departments of the division of biology, including botany, physiology and zoology and the Bussey Institution. The architecture is in the modernized Georgian style, in keeping with the surrounding buildings. It is five stories high, with red brick exterior walls on a reinforced concrete frame and white steel casement fenestration.

Two wings of the building, the right and center wings, with a combined length of approximately six hundred feet, will be constructed at this time. The left wing will be part of the proposed future addition, and with its completion a quadrangular court will be formed.

The interior of the building will provide the most complete and comprehensive facilities for the exacting and innumerable experiments of modern biological research. There are convenient laboratories of one, two, three and four units furnished with every imaginable service, rooms where the temperature can be kept indefinitely at any desired stage, rooms far underground where no outside sound can penetrate, aquarium rooms, excellently equipped photographic studios and dark rooms.

Lecture and seminar rooms are conveniently situated on all floors and in addition an auditorium seating a hundred and fifty is placed opposite the main entrance lobby. Not the least of the difficulties encountered in providing for the great numbers of laboratories and lecture rooms was the question of ventilation. An elaborate system of ducts, operated by machines on soundproof platforms in the top story, changes the air in the entire building continuously.

A large greenhouse is provided upon what would ordinarily be the roof, with arrangements for sun-seeking and shade-seeking plants and stone walls with water running down them for such plants as make their homes in water.

An unusual feature is a frieze running around the building above the upper tier of windows, formed of projecting copper-covered bosses, each showing one of the symbols of biological science.

SCIENTIFIC NOTES AND NEWS

HARVARD UNIVERSITY at its commencement exercises on June 19 conferred honorary degrees with the following citations: William Morton Wheeler—Eminent as zoologist and dean of the Bussey Institution, profound student of the social life of insects, who has shown that they also can maintain complex communities without the use of reason.—Doctor of Science. Karl Taylor Compton—A professor of physics, renowned for his contributions to its latest mysteries, the new president of the Massachusetts Institute of Technology.—Doctor of Laws.

UNION COLLEGE has conferred honorary degrees on Dr. Albert Wallace Hull, research physicist at the Research Laboratories of the General Electric Company, and on Dr. George L. Streeter, director of the department of embryology of the Carnegie Institution at the Johns Hopkins University.

THE doctorate of laws was conferred on Edward Ray Weidlein, director of the Mellon Institute of Industrial Research, at the commencement exercises of the University of Pittsburgh.

THE University of Michigan has conferred the degree of doctor of science on Dr. Alfred F. Hess, clinical professor of pediatrics at University and Bellevue Hospital Medical College, New York City, in recognition of his work on the activation of foods and sterols by means of ultra-violet irradiations.

PROFESSOR W. D. MACMILLAN, of the University of Chicago, was given the honorary degree of Sc.D. by Lake Forest College on June 7. He delivered the commencement address on "A New Interpretation of the Old Heaven."

AT the one-hundred and first annual commencement of Illinois College on June 11, the honorary degree of doctor of science was conferred on Dr. James Bertram Overton, professor of plant physiology at the University of Wisconsin, and on Dr. George Elmer Shambaugh, professor of otolaryngology at the Rush Medical School, Chicago.

REAR ADMIRAL RICHARD E. BYRD was elected an honorary fellow of the American Museum of Natural History, the highest distinction within the gift of the trustees, at a meeting held on June 19.

DR. HENRY S. PRITCHETT, president of the Carnegie Foundation for the Advancement of Teaching since its organization in 1905, has presented his resignation to take effect on August 1. He will be succeeded by Dr. Henry Suzzallo, who is a trustee of the foundation and was formerly president of the University of Washington. As president of the Teachers Insurance and Annuity Association, Dr. Pritchett will be succeeded by Professor James W. Glover, chairman of the department of mathematics of the University of Michigan.

DR. HENRY T. FERNALD, head of the department of entomology and director of the graduate school at the Massachusetts Agricultural College, will retire from active duty as professor emeritus at the end of June after thirty-one years of service. The department of entomology will be combined with the departments of zoology and geology, of which Professor C. E. Gordon is the head. Professor F. J. Sievers, director of the experiment station, will also direct the graduate school.

THE director and secretary of the Science Museum, London, Colonel Sir Henry G. Lyons, has been reappointed to hold his present office until October, 1933. Sir Henry Lyons was originally due to retire last October, on attaining the age of sixty-five years, but he was invited by the Board of Education to retain his post for a further year.

PROFESSOR HARRY E. CLIFFORD, since 1909 Gordon McKay professor of electrical engineering, has been made dean of the Harvard Engineering School, to succeed the late Hector J. Hughes, who died on March 1.

DR. M. T. TOWNSEND, associate professor of histology at the University of Oklahoma Medical School, has been appointed head of the department of biology at Illinois Wesleyan University, Bloomington.

DR. REGINALD D. MANWELL, of the School of Hygiene and Public Health of the Johns Hopkins University, has been appointed assistant professor of zoology at Syracuse University.

DR. CYRIL DARYLL FORDE has been appointed to succeed Professor H. J. Fleure in the chair of geography and anthropology at the University College of Wales, Aberystwyth.

DR. FIELDING H. GARRISON, now librarian of the William H. Welch Medical Library of the Johns Hopkins University, has been appointed resident lecturer in the history of medicine.

DR. BRADFORD WILLARD has resigned his position as assistant professor of geology at Brown University, to become associate geologist with the Topographic and Geological Survey of Pennsylvania.

DR. CHAS. M. A. STINE, chemical director of the E. I. du Pont de Nemours and Company, has been made vice-president and member of the executive committee. He is succeeded as chemical director by Dr. Elmer K. Bolton, who has been assistant chemical director under Dr. Stine.

DR. ARCHIBALD T. MCPHERSON, of Marceline, Missouri, has been appointed chief of the rubber section of the organic and fibrous materials division of the Bureau of Standards. Dr. McPherson will direct the section formerly headed by Mr. P. L. Wormelley, who has been called upon to take charge of the new section of specifications and testing. The change will become effective on July 1.

DR. HAROLD C. BRYANT, of Berkeley, California, has been appointed head of the new branch of education and research in the National Park Service. His official title will be assistant to the director and headquarters will be in the Washington office. Although his appointment will be effective on July 1, Dr. Bryant will not go to Washington until the fall, spending the intervening time in studying various natural history problems in the field.

Dr. J. H. Dellinger, chief of the radio section of the U. S. Bureau of Standards, was appointed official representative of the Institute of Radio Engineers at the seventh plenary meeting of the International Electrotechnical Commission in Copenhagen, Stockholm and Oslo, from June 27 to July 9. Dr. Dellinger sailed on June 17. It is hoped to hold the meeting of 1933 in the United States.

Dr. Eugene Pascu, of the University of Budapest, has been appointed assistant professor in the department of chemistry of Princeton University.

Dr. Frank Blair Hanson, professor of zoology in Washington University, is on leave of absence for the school year 1930–31. After July 1 he may be addressed care of The Rockefeller Foundation, Paris.

Dr. D. J. Healy, of the department of animal pathology at the University of Kentucky, has been granted a leave of absence for several months to go to Harvard University at the invitation of Dr. Roy Graham Hoskins, where he will be associated with Dr. Hoskins in work to develop technic in studying mineral metabolism and the functions of ductless glands.

Dr. Stanley D. Wilson, professor of chemistry and dean of the College of Science of Yenching University, Peiping, China, will spend the year 1930–31 in study and research chiefly at the University of Chicago.

At the Polytechnic Institute of Brooklyn, N. Y., Professor Vladimir Karapetoff, of Cornell University, and Dr. Ernst Weber, lecturer in the Technical School at Berlin, Charlottenburg, have been appointed visiting professors of electrical engineering. Dr. Weber takes the place of Dr. Bernard Hague, who returns to the University of Glasgow. Professor Clyde Whipple, assistant professor of electrical engineering, has been given a year's leave of absence to enable him to serve as visiting professor at Princeton University.

Dr. William H. Welch is visiting Pasadena, California, in order to make a study of the collection of books of the fifteenth, sixteenth and seventeenth centuries in the Harry E. Huntington Library.

Among foreign men of science who are expecting to visit the United States under the auspices of the International Institute of Education are Dr. Arthur Haas, professor of physics, and Dr. Eugen Oberhummer, professor of geography, both of the University of Vienna, and Dr. Basil M. Bensin, of the Agricultural Association of the Czechoslovak Republic.

Professor R. A. Morton, of the University of Liverpool, lectured at the Iowa State College from June 11 to 13. His lectures dealt with the study of absorption spectra and applications of this study to chemistry and to biological problems. Dr. Filippo Silvestri, director of the College of Agriculture at Portici, Italy, delivered a series of lectures on economic entomology from June 16 to 19.

Mr. C. F. Kettering, of the General Motors Corporation, Dayton, Ohio, has given to Antioch College $200,000 for the study of certain phases of photosynthesis. Dr. O. L. Inman will be in charge of the investigation, which is planned as a ten-year research project.

At the annual dinner of the faculty and alumni of Rush Medical College of the University of Chicago, on June 10, it was announced that Dr. Frank Billings, for many years professor of medicine and dean of the faculty, has given $100,000 to establish four fellowships at Rush Medical College. They are to be named in honor of Drs. Edwin R. Le Count, professor of pathology; Ernest E. Irons, dean and professor of medicine, and Wilber E. Post and Rollin T. Woodyatt, clinical professors of medicine.

Three fellowships in fisheries research have been provided at the University of Michigan by the Michigan Division of the Izaak Walton League of America, and two additional fellowships are offered by the Institute for Fisheries Research. These involve both field and laboratory studies on some practical fishery problem in Michigan. The stipend varies from six hundred to twelve hundred dollars.

Mr. and Mrs. Charles P. Hood, of Boston, have made a gift to the University of New Hampshire of $125,000 to be used at the discretion of the trustees.

An appropriation of $6,500,000 for the extension of the natural history building of the Smithsonian Institution would be authorized under the provisions of a bill (S. 3970), passed by the House on June 16. The bill would provide for additions to the east and west wings of the National Museum.

The cornerstone laying ceremonies of Ryder Hall, the new electrical engineering laboratory of Union College, Schenectady, took place on June 14 in connection with the one hundred and thirty-fourth commencement. Harold Russell Ryder, New York, donor of the building, laid the cornerstone. Dr. Edwin W. Rice, Jr., trustee of the college and honorary chairman of the directors of the General Electric Company, officially presented the building to the college, and it was accepted by President Frank Parker Day.

The forty-eighth annual meeting of the American Ornithologists' Union has been announced for the week beginning October 20, at the Peabody Museum at Salem, Massachusetts.

AT the last meeting of the College of Medicine of the University of Illinois Chapter of Sigma Xi, seven candidates for active membership and six candidates for associate membership were initiated. Dr. Lloyd Arnold presented his results on "An Experimental Study of Host Susceptibility to Vibrio Cholera Infections." For the ensuing year the following officers were elected: Dr. William F. Petersen, *president;* Dr. W. J. R. Camp, *vice-president;* Dr. William H. Welker, *secretary;* Dr. I. Pilot, *treasurer,* and Dr. Hugh A. McGuigan, *elective member of executive committee.*

AN appropriation of $50,000 to enable the Secretary of Agriculture to purchase a collection of moths and butterflies owned by the late Dr. William Barnes, of Decatur, Illinois, has been recommended by President Hoover. The collection, which consists of 473,000 specimens, would be housed in the National Museum.

THE American Engineering Council announces the appointment of a committee to cooperate in the publication of a new edition of "Who's Who in Engineering." The function of the committee, according to Mr. Lawrence W. Wallace, executive secretary of the council, is "to provide such advice on the qualifications of engineers as will enable the publishers to issue a work which shall be authoritative." The members of the committee are: R. F. Schuchardt, chief electrical engineer, Commonwealth Edison Company, Chicago; John S. Conway, Washington; Dr. Harry A. Curtis, Department of Chemical Engineering, Yale University; C. R. Dooley, Standard Oil Company, New York City; Colonel Frank M. Gunby, associate, Charles T. Main, Inc., Boston; Arthur Huntington, Iowa Railway and Light Corporation, Cedar Rapids, Iowa; B. A. Parks, Byron E. Parks and Son, Grand Rapids, Michigan; Dr. H. S. Person, managing director, Taylor Society, New York City; Dean A. A. Potter, School of Engineering, Purdue University, Lafayette, Indiana; George S. Rice, chief mining engineer, U. S. Bureau of Mines; F. F. Sharpless, consulting engineer, New York City; Robert Sibley, executive manager, California Alumni Association, University of California; Major Brehon B. Somervell, district engineer, U. S. Engineer Corps, Washington. The committee represents membership in the following societies: American Institute of Chemical Engineers, the American Institute of Electrical Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Agricultural Engineers, the American Society of Civil Engineers, the American Society of Mechanical Engineers, the Grand Rapids Engineers Club, the Society of American Military Engineers, the Society of Industrial Engineers and the Taylor Society.

DISCUSSION

THE QUESTION OF THE CENTRAL BODIES

IT has been suggested of late that the so-called central bodies (centrosomes, centrioles) long ago made known by Flemming, Van Beneden and Boveri, and later studied by many other expert cytologists, have no objective existence in the living cell—that they are, in fact, either coagulation-artifacts or the offspring of an unholy union between random granules in the cell and an over-developed will to believe on the part of the observer. Could this be substantiated, it would constitute an important discovery—psychological as well as cytological—and assuredly the questions thus raised should have every opportunity for critical test. In the meantime, I will briefly indicate some of the grounds for thinking that the central bodies may for the present maintain a modest footing in respectable biological society.

Two of the classical objects that have played a leading part in the development of our knowledge in this field are the germ-cells of the nematode *Ascaris megalocephala* and of the annelid *Chaetopterus,* the former having long ago provided the material for the pioneer researches of Van Beneden, Boveri and Brauer, the latter for the important later work of Mead. Both these cases are now in course of reexamination in the Columbia Laboratory. The work of H. P. Sturdivant, dealing especially with the sperm-forming divisions in *Ascaris,* and later to be reported by him in detail, has produced decisive confirmation of the most essential results concerning the central bodies made known by Boveri, O. Hertwig and Brauer. The case of *Chaetopterus,* including the history of the central bodies in maturation, fertilization and cleavage, is being reviewed by the writer in a study of Mead's original preparations and drawings, a large number of which have generously been placed in my hands for the purpose. Many of these preparations, as might be expected after thirty-four years, are now badly faded, though they show good promise of successful restaining. Fortunately, however, a sufficient number have retained their original brilliancy to make possible a close study, with the best modern optical apparatus, of all the essential phenomena recorded by Mead in 1898; and in a number of cases a thorough examination could be made of the same individual sections, some of them still of great beauty, from which the original figures were drawn.

It is a pleasure to bear witness to the fine quality of these admirable preparations, to the exceptional precision with which they were described and figured and to the faithfulness of Werner and Winter's lithographic reproductions of the original drawings. The figures do not exaggerate the clearness of the preparations; they are not schematized; they represent accurately the facts as they were seen and in large measure may still be seen. No critical observer, I think, who closely studies these preparations could take seriously the naïve notion that the centrioles are merely random granules that happen to lie at or near the astral centers. The assumption that they are merely the coagulated central portions of the astral rays deserves more respectful consideration, but this too seems to me inadmissible in view of the fact that both in maturation and cleavage the centriole is double from the metaphase onwards, and that during the anaphases its halves are more or less widely separated at a time when the asters show no sign of duality, before they have begun to elongate at right angles to the spindle-axis and before the small daughter-asters of the telophase have appeared. Similar conditions are seen with equal clearness in the *Ascaris* spermatocytes, and in great numbers of cells.

In respect to the genetic relations of the central bodies, it must be plain to every observer that in these objects some kind of genetic continuity is maintained between the astral systems of successive divisions. From the first appearance of the polar asters in *Chaetopterus* down to their disappearance after the second polar division, and then again from the first appearance of the sperm-aster through all the operations of fertilization and the earlier cleavages, the new asters arise at each step within, or in close proximity to, the preceding ones. All points to the conclusion that, in these divisions at least, this relation is determined by the centrioles, which are handed on bodily from cell to cell and act as centers for the formation of new asters in each succeeding generation. In respect to all this, and much more, the *Chaetopterus* preparations show a remarkably close and detailed resemblance to the conditions figured and described by Coe in *Cerebratulus* and by Griffin in *Thalassema*, and they are in substantial agreement with the results of many other accurate observers of the same period, including Boveri, Meves, Heidenhain, Ballowitz, Kostanecki, MacFarland, Vejdovsky and others who contributed to the development of the classical view.

For the foregoing reasons I am convinced of the objective existence of the central bodies as normal components of the cell (I do not say of all cells) and of the correctness in principle of the conclusions concerning them drawn by Mead and his fellow workers in this field. Doubts concerning the centrioles have sometimes been caused by considerations relating to the technique of staining. It was long ago demonstrated by Boveri (1901) that so long as the centriole remains single its existence within the centrosome or aster is not susceptible of rigorous demonstration by the regressive methods of staining in iron-hematoxylin, for the apparent size of the centriole may be varied at will, down to seeming disappearance, by extracting the dye in successive degrees. But at certain stages, as above indicated, two centrioles are regularly found at a time when the centrosome or aster is still single—a condition explicable neither as a product of centripetal or concentric extraction (as Boveri also pointed out) nor of mere coagulation of the rays. As a third possibility, the centriole might be thought of as no more than a focus of centripetal condensation within the aster, having no sharply marked boundaries, yet capable of division as if it were an individualized body, and offering the aspect of such a body after centripetal extraction. Such a notion is hardly different in principle from the classical conception, but it introduces new and perhaps insurmountable difficulties, particularly in view of the fact (apparently well established) that in some cases the centriole may persist, as a double structure, in the absence of asters, during the whole interkinetic phase of the cell.

Edmund B. Wilson

Columbia University

CREDIT OR RESPONSIBILITY IN SCIENTIFIC PUBLICATION

May I venture a comment bearing on the question of credit for illustrations in connection with recent letters by Dr. Stiles and Dr. Mueller? Every one must acknowledge the justice of the criticisms made by both writers, but in neither case is there any practical method of securing real justice. Most illustrations of value enough to be frequently copied are the result of the combined effort of quite a number of individuals. A restoration of an extinct animal owes much of its value to the artist who drew it and likewise to the scientist who deduced from its skeleton the resemblances to and differences from existing animals that must serve the artist as his guide, who in many cases provided the artist with sketches or rough drawings to finish for publication. But no less it is the work of the skilled preparator who, guided by expert practical knowledge of osteology, has spent months of labor in piecing and articulating the skeleton; and to the equally skilled field man who spent months in the bad-lands searching for it, and when found knew how to bring it all in in such condition that it could be reconstructed by the preparator. Who is to decide what meed of credit belongs in each instance to each man? And how about the great foundation or the generous donor whose money has paid for all this work? Most important contributions to science nowadays are composite work, of which the author's contribution is often only a minor part. Yet we continue to apply to them standards of professional ethics derived from a time when most research contributions were from start to finish the work of the author, usually on his spare time; and any minor aid from others was acknowledged.

All this discussion of credit omits the really important and essential reason why an author's name is attached to a published contribution or illustration. He is the party responsible for the statements, results and conclusions therein. That is the point with which the reader of the article is chiefly concerned. Scientific publications are printed and distributed primarily for the benefit of the reader, not to enhance the reputation of the writer. We are all apt to forget that, being all egoists in varying degree, but it is nevertheless true and should be kept in mind in discussing professional ethics. What concerns me when I am reading a scientific paper is how far I should accept its statements and conclusions, whose authority lies back of its illustrations—who is responsible. I don't care who made the drawings, so that they are certified as accurate by a reliable authority. Nor do I care who collected or prepared the specimens, so that my authority is responsible for stratigraphic and collecting data and reconstruction. As a side issue and a matter of personal acquaintance with the men concerned, these points may be of interest. But my prime concern is to get hold of as much authoritative, well-expressed information as possible in the field covered, and to size up just how far I can trust in its accuracy and thoroughness.

This I take it is the practical reason why an article or illustration in a scientific journal should be, as it usually is, credited to author A, even though most of the work was done by assistants B and C, artist D, preparator E and collectors F, G and so on. In an art magazine the artist would naturally be cited as author of the illustrations, as the reader would care very little about the scientific soundness. In a popular book or magazine they would usually be credited to the collaborator who had the biggest newspaper reputation. The late Mr. Carnegie is presenting a Diplodocus to Mexico. That is the aspect of the transaction that interests the public. But the Mexican scientist who studies that reconstruction regards Dr. Holland as his authority for its accuracy. I see no more reason why Professor Berry in copying a restoration of *Diatryma* should credit it to the artist instead of the authors than for the text-book in which it appears to be called McGraw-Hill's "Paleontology" instead of Berry's.

As to the "customary acknowledgments" in a scientific article, they may relieve the conscience of the author, but does any one really suppose that a line or two in the introduction which nobody reads does justice to the part played by a collaborator who often has contributed much more work than the author and sometimes more brains? His real profit lies in the fact that he has got his work and his ideas on record, accessible to all who are interested. That is what we all profess to be working for in scientific research. If personal credit is all that concerns us, let us drop the hypocrisy of pretending otherwise, or claiming that the world owes any special recognition or reward to our "unselfish efforts."

W. D. MATTHEW

UNIVERSITY OF CALIFORNIA

GENETICS

I HAVE just received the third edition of Walter's "Genetics," of which it may be said that it is well written, comprehensive and essentially up to date. But it seems to me to start out with an extraordinary confusion of ideas. A diagram represents "the triangle of life," the three sides being heritage, environment and response. It is said that when this idea is applied to man, "there are theoretically at least a minimum of twenty-seven possible kinds of human beings, as shown in Fig. 2." Fig. 2 shows "The scale of success. A stands for high grade; M for mediocrity; Z for low grade." These grades are assumed to exist in respect to each side of the triangle, and to vary independently. Thus No. 4 has first-class heredity and environment, but exhibits Z response or conduct. No. 25 has Z heredity and environment but A conduct. Now it is certainly true that the springs of human personality are far too subtle to be completely "explained" in scientific terms, but from any point of view, the exhibit in Fig. 2 is contrary to reason and experience. Further confusion of ideas is shown in the definition: "Response, on the other hand, represents what the individual *does* with his heritage and environment. It is what may be described as the training or educational factor, most clearly demonstrable in the higher animal forms."

The book also reminds us of a serious dilemma which confronts teachers of genetics, or indeed of scientific subjects in general. The subject-matter has grown enormously in recent times, and when the resulting complexities are presented in a text-book, the necessary consequence is that more and more this takes on the form of an encyclopedia or dictionary. Yet it can not be said that any of the items are unimportant. It seems to me that from a pedagogical standpoint we shall be compelled, in beginning courses, to eliminate many of the topics, and treat the rest more fully and interestingly. By so doing we may create an enthusiasm for the subject and produce a far more permanent impression than is derived from a multitude of half-understood facts memorized for the examination.

T. D. A. Cockerell
University of Colorado

MALFORMED LEG BONES IN YOUNG CHICKENS

A condition in young growing chickens referred to by different ones as leg weakness, rickets, enlarged hock joints, slipped tendons and malformed leg bones has become serious in many sections of the country. The condition is aggravated by intensive methods of production such as confinement in small runways and storage brooders where exercise is limited.

This deformity differs from rickets since it develops in the presence of vitamin D and a well-balanced mineral mixture. Between the ages of three and six weeks the hock becomes enlarged, probably on account of edema and slight hemorrhages usually found in the tissue surrounding the joints. The gastrocnemius or main tendon which extends the foot and flexes the leg occasionally slips from the condiles which hold it in place. This may be responsible for the stiffening and malposition of the leg below the hock joint as found in advanced cases. Either or both the femur and tibia may become enlarged or develop marked curvature and one or both legs may be involved. The legs may bow out, curve in or take on other unusual shapes.

The number of chicks affected in a flock has been observed to vary from 1 to 60 per cent. The trouble has not been confined to any group of conditions. It may be found in both slow and rapidly growing chicks, with all-mash or with grain and mash rations, on wire and board bottom runways and with high and low mineral content in the rations.

The departments of poultry husbandry, chemistry and pathology at the Kansas Agricultural Experiment Station are now working together in a cooperative experiment to find if possible the cause of this trouble.

Loyal F. Payne
Kansas State Agricultural College

QUOTATIONS

ELMER A. SPERRY

"The lot of every one of us," wrote Horace, "is tossing about in the urn, destined sooner or later to come forth and place us in Charon's boat for everlasting exile." This time the lot has come forth for one whose going the whole planet will regret. A passenger on the high seas, remembering the fate of Palinurus, wrote of this great inventor whose mechanical helmsman, called familiarly the "Metal Mike," now guides great ships to their desired havens:

Now is old Palinurus' occupation gone;
  It has been taken o'er by one named Sperry
Who has installed a "Metal Mike" instead—
  He'll soon be putting one on Charon's ferry.

Unhappily for us who still remain this side the River of Woe, Mr. Sperry has gone to his "aeturnum exsilium," but he has left among men an everlasting fame, and imagination allows one to think of his inventive spirit making suggestions to the ferryman about improving service in the crossing for the benefit of those who have to take it later. For Mr. Sperry was ever thinking of how he might make the dwellers on earth a little more at ease whether on sea or land or in the air. For those who travel by sea he provided not only the pilot, who whatever betides holds his rudder true, but also a "stabilizer" to prevent the rolling of the ship and a device for signaling to prevent collisions. For those who travel by air he has helped to maintain the equilibrium of their planes and to lessen the peril of fire and to penetrate the fog. Towards the end of his long series of inventions he perfected an instrument for detecting the slightest imperfection in a steel rail.

What his born genius for invention would have done for a slower-going civilization one cannot imagine, so closely has it been associated with the swifter agents of this mobile age. He would have been put among the Titans in the ancient Greek age. But with all his seemingly miraculous achievements, he who harnessed the motion of the earth to do his bidding was a gentle human being, generous in his sympathies and beloved in his own person. America, claiming him for her own and proud of his contributions, which were recognized by the highest honor bestowed by his own profession in his own country, remembers with special satisfaction that he was acclaimed by his fellow-engineers of the world, when he presided at the International Congress of Electrical Engineers in Japan last year.—*The New York Times.*

SCIENTIFIC BOOKS

Lehrbuch der Protozoenkunde, eine Darstellung der Naturgeschichte der Protozoen mit besonderer Berücksichtigung der parasitischen und pathogenen Formen. Begründet von FRANZ DOFLEIN, neubearbeitet von EDUARD REICHENOW. Ed. 5, Jena, Verlag von Gustav Fischer. vi + iv + vii + 1262 pp., 1201 figs. in text. 1927–1929. Price, bound, 70 marks.

AMONG the many German text-books of specialized nature issued by the well-known publishing house of Gustav Fischer, few, if any, have had the cordial reception which has been accorded to Doflein's "Text-book of Protozoology," and none has had a wider usefulness. This has been in part due to the key position which the Protozoa hold in the field of biology. They are first in the evolutionary series of animal forms, and have intimate relationship with the plant series. They present extraordinary diversifications in structure and life history; their ecological adaptations bring them into the most diversified environments; their cytological developments surpass those of all other cells in the complexities and modifications which have emerged in the long period of their evolution; it is probable that the number of species now living will be found to exceed that of all other animals, the insects included, and their interrelations in the web of life link them in intricate chains of food relations, soil conditions, oceanic deposits, commensalism, symbiosis and disease. Scarcely an animal or plant exists that is not in one or many ways entangled in this web with the Protozoa.

The merit of the series of editions of Doflein's text-book lies in the fact that he grasped the wide significance of the relationships of the Protozoa, advanced each successful edition in the forefront of this rapidly progressing science, and was never provincial in his grasp of his field or in its presentation.

In addition to these qualifications he organized his material logically, developed it symmetrically and presented it with lucidity and forcefulness. He had a keen scent for the significant organisms or features of structure—a fact revealed in the selection of subjects for his own contributions to protozoology. Protozoologists and biologists generally have come to await with eagerness the next edition of Doflein in order that they might catch up with the broader aspects of the subject. Although he always presented the parasites and pathogenic aspects of the Protozoa, he never subordinated their broader biological phases to these more practical or immediately useful subjects, as has been notably done in Wenyon's recent "Protozoology."

Another feature of Doflein's authorship which is distinctive and for which the publishing house of Fischer is also to be congratulated is the high standard of artistic and technical skill in the illustrations. New and original illustrations were often prepared, figures from other investigators never suffered at his hands and a wealth of carefully selected figures adorns nearly every page of the large volume.

The new edition prepared by Dr. Eduard Reichenow, professor and director of the protozoological division of the widely known Hamburg School of Tropical Medicine, follows in the main very successfully along the lines of the earlier editions. Changes involved are the entire omission of the Spirochaetes, which, quite properly, are now relegated to the Bacteria. New illustrations, many of them original from Doflein, to the number of several hundred, have been introduced; the formerly separated sections on morphology and on physiology are quite significantly combined in one.

More than ten years have elapsed since the fourth edition was published. The great volume of new material which has been published in the intervening years has compelled a rewriting of almost the entire text, which, together with the vast array of material to be reviewed, is no small undertaking. This fact is doubtless responsible for the relatively larger use made of German sources in this revision as compared with the earlier ones.

This is hardly the place for a critical survey of the details of the new edition, but only for a brief characterization. The text, in comparison with the best edition, is in a somewhat more involved style; there is a relatively greater proportion of German work in the new bibliographic citations, and there is a considerably fuller presentation of the parasitic genera and species, which will doubtless meet with approval of many users of this monumental work.

The reviser is to be congratulated on the high order of scientific service rendered in the preparation of this summary of a field so wide, so diverse and so widely useful. The publisher has also given the book the fitting set-up which biologists the world over have long associated with his imprint.

CHARLES A. KOFOID
DEPARTMENT OF ZOOLOGY
UNIVERSITY OF CALIFORNIA

Der Hochgebirgssee der Alpen. By OTTO PESTA. Bd. VIII of Thienemann's Binnengewässer, 1929, 156 pp., 8 pls., 41 figs. Published by E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart.

THE author restricts the term "high mountain lakes of the Alps" to those bodies of water that are situated above the timber line, which lies at 1,800 to 2,000 meters above sea-level in this region. These elevated bodies of water range from mere tarns up to 148 hectares in area; only two of them exceed 100 hectares, while five exceed 50 hectares. The shores usually consist of gravel and boulders.

One lake is 102 meters deep and 28 are more than 30 meters deep; most of them range from 1.8 meters to 30 meters in depth. Some of the lakes are fed by glacial waters and the detritus therein gives the lake water a milky appearance. A few have dark-colored water, but most of them are green or blue-green to blue in color.

The summers are short but rather warm at this altitude; in the deeper lakes the temperature of the surface water ranges from 10° to 14°, or even 20° C. in summer, while the bottom temperatures are 3.8° to 5.6° C. In some of the more elevated lakes the surface temperature is as low as 1.5° to 4° in August. As a result of the severe climatic conditions at this altitude the various bodies of water are covered with ice from 150 to 270 days each year; a few of them may be frozen for 300 days or even the entire year at certain times. The thickness of the ice varies from 49 to 87 centimeters.

The waters of these lakes hold a relatively small amount of salts in solution so that the dry residue is small, ranging from 0.4 to 30 milligrams per liter. In general, calcium is the chief mineral constituent. The water contains an abundance of dissolved oxygen, but the amount is below the saturation-point in all cases.

Very few large aquatic plants are found in these lakes because the growing season is short and the temperature is low; also the bottom is unfavorable for attached plants because it consists of gravel and boulders. Several of the green algae, such as Spirogyra, Zygnema, etc., are found more or less abundantly in some of the lakes. The low temperature of the water and the small amount of salts are unfavorable factors for the phytoplankton; diatoms seem to withstand these conditions much better than the green algae. Peridinians and flagellates are found to a limited extent in the summer.

Animal forms are represented by amphibians, fishes, mollusks, insects, crustacea, rotifers, worms and protozoa. The biology, ecology and origin of the fauna are discussed at some length. The bibliography contains a list of 142 titles.

CHANCEY JUDAY

WISCONSIN GEOLOGICAL AND
NATURAL HISTORY SURVEY

Antarctic Adventure and Research. By GRIFFITH TAYLOR. Appleton (New World of Science Series), 1930. 245 pp., 34 figs. $2.00.

THE appearance of this little book from the pen of Captain Scott's senior geologist on his last expedition, now holding the chair of geography at the University of Chicago, is most opportune when so many are stimulated to inquiry into Antarctic conditions. It might well be doubted if there is any one to-day better fitted to treat of this broad subject. Professor Taylor's background is well displayed in his summary of Antarctic exploration which occupies the first eighty-two pages of the book. The *raison d'être* of each expedition, the importance which it assumes and the results which were achieved are all treated with a thorough grasp of the subject and with a brevity which is masterly. The delicate international questions which have sometimes been involved are dealt with fully and fairly.

The remaining chapters of the book are devoted to "The Continent, its Geology and Relation to Other Lands," "Scenery and Topography," "Ice-sheets and Glaciers," "Oceanography and Sea Ice," "Climatology," "Flora and Fauna" and "Commercial and Political Aspects." The more important reference works for each chapter are cited and evaluated, and the book has a good index. The thirty-four text illustrations, though a little crude and sketchy in character, are none the less very helpful in the exposition of the subject. A surprising amount of accurate and well-arranged scientific material has been compressed into this little book, though the interest is kept up to the end. It is to-day the best book on the subject which it treats.

WM. H. HOBBS

UNIVERSITY OF MICHIGAN

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN IMPROVED COLOR STANDARD FOR THE COLORIMETRIC DETERMINATION OF CHLOROPHYLL[1]

A RAPID and accurate method of measuring quantities of chlorophyll in plant extracts reported previously[2] included the use of an appropriate color standard and a colorimeter. The color standard was prepared by mixing stock solutions of the dyes, Malachite Green and Naphthol Yellow, in such proportions that the tint was practically identical with that of solutions of saponified chlorophyll. Evaluation of the color standard in terms of known concentrations of chlorophyll made it possible to determine the chlorophyll content of certain strains of corn in a convenient manner.[3] The procedure outlined offers a new approach to the important problem of determining the relation between quantities of chloroplast pigments and plant growth.

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[1] Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Agronomy.

[2] Howard B. Sprague, "A Convenient Method of Measuring Quantities of Chloroplast Pigments," SCIENCE, 67: 167–169, 1928.

[3] Howard B. Sprague and J. W. Shive, "A Study of the Relations between Chloroplast Pigments and Dry Weight of Tops in Dent Corn," *Plant Physiology*, 4: 165–192, 1929.

In making use of the method for studies concerning the nutritive value and chlorophyll content of plant tissue, the second author of this note found it desirable to modify the color standard by changing the relative proportions of the two dyes. The modified color standard is more satisfactory for general work than the one described previously, since it produces a more perfect match in color with chlorophyll extracts of various plants. It is prepared as follows.

Nine tenths cc of a ½ per cent. aqueous solution of Malachite Green and 11.2 cc of a ½ per cent. aqueous solution of Naphthol Yellow are made up to 5,500 cc with distilled water. The concentration of color in this standard is the equivalent of that produced by 11.873 milligrams of chlorophyll saponified to chlorophyllins and diluted with water to make one liter.

Several investigators have called attention (in personal correspondence) to the variability in different lots of Malachite Green and Naphthol Yellow which may be purchased. Because of this situation, lots of dyes from a number of sources have been compared with the original dyes[3] used in preparing the standard. The following lots of Malachite Green were apparently identical with the original lot: (1) *Malachite Green Crystals,* 1264, Research Laboratory, Eastman Kodak Company; (2) *Malachite Green Crystals,* the Coleman and Bell Company; (3) *Malachite Green,* for histological use, Schultz No. 495, C. I. 657, National Aniline and Chemical Company, "Found satisfactory by commission on standardization of biological stains for above-mentioned purposes."

Malachite Green 0926, Dr. Grübler and Company, Leipzig, Germany, was identical in color but more concentrated than the original lot of dye. *Malachite Green Hydrochloride,* the Coleman and Bell Company, proved unsuitable for this purpose.

The several lots of Naphthol Yellow tested were identical in tint with the standard lot of this dye, but all required filtering except the Martiusgelb of Grübler. One half per cent. aqueous solutions of each lot of dye tested were made with distilled water and allowed to stand for several hours until maximum solution at room temperature was obtained, and then filtered with No. 42 Whatman filter-paper. With this treatment, the following lots of dye gave filtrates identical in color and concentration with the standard lot of Naphthol Yellow: (1) *Naphthol Yellow S,* National Medicinal Products, National Aniline and Chemical Company; (2) the same label as No. 1 but distributed by the Eastman Kodak Company; (3) *Naphthol Yellow,* E & A Biological Stains, B 119, Eimer and Amend.

The *Martiusgelb* of the Dr. Grübler and Company proved less concentrated than the original dye, likewise the *Martius Yellow* (Naphthol Yellow) Schultz No. 6, C. I. 9 of the National Aniline and Chemical Company. The latter dye bears the additional statement, "Found satisfactory by commission on standardization of biological stains, for use in histology, especially the Pianese triple stain." The *Naphthol Yellow* sold by the Fisher Scientific Company was more concentrated than the original standard dye.

It is suggested that workers expecting to make use of the chlorophyll color standard described in the foregoing in any extensive investigations purchase a considerable quantity of the satisfactory lots of dye.

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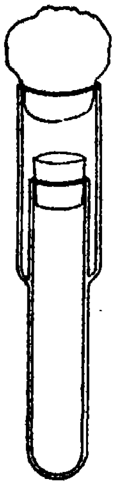
A STORAGE TUBE FOR PLASMA AND EMBRYO JUICE

IN cultivating mammalian tissues *in vitro* the problem of containers for the storage of embryo juice and plasma is often a vexing one since it is difficult to insure effective cooling and sterility and at the same time to facilitate the handling of these substances. In our laboratory we have devised a double-necked tube which has proved very efficient and which may be of interest to others engaged in similar problems, as it avoids these difficulties. The single tube in common use is very subject to infection in the ice pack, and the constant flaming besides being a nuisance hastens clotting. The double tube described by Strangeways, while insuring sterility, is difficult to cool and in operation has the same objections as the single tube. To overcome these difficulties we prepared a tube with a double neck fashioned in such a manner that the outer neck was somewhat longer than the inner one in order that each could be plugged independently. The lower end of the tube being of a single thickness is in direct contact with the ice and insures cooling. The opening of the outer neck is plugged with cotton which may be removed by the fingers. The inner neck-opening is plugged with a sterile cork and can be removed with sterile forceps. This double protection has many advantages that facilitate operation.

Used in place of the usual tube in centrifuging the rat plasma, the double plug insures sterility without flaming and removes the risk of raising the temperature and hastening clotting.

In the operation of mounting the cultures the containers for the embryo juice and the plasma must be opened many times. This operation necessitates flaming each time to avoid infection and is time consuming. Used in this operation the double-necked tube is supported in the ice pack at an angle of 45°. When the inner plug has once been removed it is left out, the outer cotton plug alone being used. This may freely be removed and replaced many times without flaming. The tube can thus be used throughout the operation (in our case thirty cultures) without removal from the ice pack, with much saving of time and no danger of infection. Even in experiments where heparin is used to prevent clotting and the ice pack dispensed with the double-necked tube saves much time and is an additional precaution against contamination.



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As will be seen from the diagram this tube consists of a small test-tube 7½ cms in length, 1½ cms in diameter and rounded off at one end. A collar is fused to this tube about 2 cms from the open end. It projects 3 cms beyond the open end of the inner tube. The jacket has a total length of 5 cms and a diameter of 2 cms.

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SPECIAL ARTICLES

VITAMIN B_2

Whereas considerable progress has been made on the concentration of vitamin B_1, comparatively little work has been reported on the purification and concentration of vitamin B_2. Within the last year only two communications, one by Chick and Roscoe,[1] and the other by Narayanan and Drummond,[2] have appeared on this subject. In the first paper a partial separation of the B_2 fraction from B_1 is reported. The process leading to the separation was very complicated, involving many steps. In the second paper, which has appeared very recently, vitamin B_2 is active in daily doses of 0.006 gm.

Over a year ago, we succeeded in separating the B_2 fraction from B_1 in a very simple way. Itself added to a vitamin B-free diet, it did not maintain growth of white rats; with 0.00015 to 0.0002 gm of our vitamin B_1 fraction, it maintained normal growth.

Fraction B_1 is adsorbed on silica gel at pH 3. The filtrate is rich in vitamin B_2, but still contains some vitamin B_1. By precipitation with acetone a material is obtained of which daily doses of 0.015 gm in addition to 0.0002 gm of B_1, both added to the standard diet, suffice to maintain normal growth of white rats. By repeating the extraction six times, a material is obtained from the filtrate of which daily doses of 0.005 gm are required. Finally, when this material is dissolved in water and precipitated with alcohol containing one per cent. of hydroiodic acid, a material is obtained of which daily doses of 0.0007 gm suffice to maintain normal growth of white rats.

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THE BEHAVIOR OF WINTER WHEAT IN ARTIFICIAL ENVIRONMENTS

In physiological investigations of diseased as well as healthy winter wheat plants, frequently it has not been possible to obtain satisfactory results with the plants produced in greenhouses and experimental culture chambers. Such plants produce abnormally long leaves and leaf sheaths, and tillering tends to be reduced during the early growth stage (predormant stage) previous to the stage of winter dormancy as compared with plants grown in the open. These abnormalities have made it practically impossible to study the rosette phase of the wheat-mosaic disease under controlled conditions throughout the year, and to obtain satisfactory heading in winter varieties.

In 1925, studies were started with the definite aim of determining methods for obtaining normal winter wheat, especially during the predormant growth stage in experimental culture chambers.

As a basis for determining normal development, measurements were made on field-grown Harvest

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[1] Chick, H., and Roscoe, M. H., *Biochem. J.*, 23: 504 (1929).

[2] Narayanan, B. T., and Drummond, J. C., *Biochem. J.*, 24: 19 (1930).